FISCAL YEAR 1984 DEPARTMENT OF ENERGY AUTHORIZATION

(Nuclear Fission R&D and Waste Management)

HEARINGS

BEFORE THE

SUBCOMMITTEE ON
ENERGY RESEARCH AND PRODUCTION

OF THE

COMMITTEE ON
SCIENCE AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES

NINETY-EIGHTH CONGRESS

FIRST SESSION

FEBRUARY 22, 23, 24; MARCH 2, 8, 9, 1983

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H501-15

CONTENTS

WITNESSES

February 22, 1983:

Page

Shelby T. Brewer, Ph. D., Assistant Secretary for Nuclear Energy, Department of Energy 5

Kermit O. Laughon, Sr., Director, Office of Spent Fuel Management and Reprocessing Systems 68

Gordon L. Chipman, Jr., Deputy Assistant Secretary for Breeder Reactor Programs; accompanied by John Longenecker, Acting Director, Office of Breeder Demonstration Projects; and William Nelson, Acting Director, Office of Breeder Technology Projects 88

February 23, 1983:

John J. Kearney, Sr., vice president, energy and environmental activities, Edison Electric Institute, Washington, D.C 119

Morgan Dubrow, senior staff engineer, National Rural Electric Cooperative Association 125

John Taylor, director, Nuclear Power Division, Electric Power Research Institute, Palo Alto, Calif 128

John Yasinsky, general manager, advanced power systems division, Westinghouse Electric Corp., Pittsburgh, Pa 141

R. B. Richards, general manager, Advanced Reactor Systems Department, General Electric Co., San Jose, Calif 160

Alvin Weinberg, Institute for Energy Analysis, Oak Ridge, Tenn 180

S. Jacob Scherr, senior staff attorney, Natural Resources Defense Council, representing the Taxpayers Coalition Against Clinch River; accompanied by Jill Lancelot Greenbaum, director, congressional affairs, National Taxpayers Union 192

Appendix: Supplemental questions and answers were received from:

Edison Electric Institute 307

Electric Power Research Institute 315

Nuclear Attaché, French Embassy 353

Letter to Chairman Bouquard from the Electric Power Research Institute on DOE light water reactor safety-related R&D 377

Westinghouse Electric Corp 382

National Rural Electric Cooperative Association 385

General Electric 388

Electric Power Research Institute 399

Natural Resources Defense Council, Inc 406

February 24, 1983:

Robert L. Morgan, Project Director, Nuclear Waste Policy Act Project Office, Department of Energy, accompanied by Michael J. Lawrence, Director of Storage 461

Appendix: Supplemental questions and answers received from the Department of Energy 496

March 2, 1983:

E. Linn Draper, Jr., senior vice president for external affairs, Gulf States Utilities Co., on behalf of the Edison Electric Institute, the Utility Nuclear Waste Management Group, and the American Nuclear Energy Council 565

Thomas A. Cotton, senior analyst, Office of Technology Assessment, Washington, D.C 577

March 2, 1983—Continued

Page
Raul A. Deju, director, basalt waste isolation project, Rockwell International Corp., Richland, Wash 594
John E. Gray, Chairman, International Energy Associates, Ltd., Washington, D.C 609
Vincent S. Boyer, senior vice president for nuclear power, Philadelphia Electric Co 628

Appendix: Supplemental questions and answers received from:

Rockwell International 643
Office of Technology Assessment 645

March 8, 1983:

Gordon L. Chipman, Jr., Deputy Assistant Secretary for Breeder Reactor Programs, Department of Energy 658
Jack L. Kerrebrock, Associate Administrator, Office of Aeronautics and Space Technology, Washington, D.C 677
Robert S. Cooper, Director, Defense Advanced Research Project Agency, Arlington, Va 686
Donald G. Rea, assistant laboratory director for technology and space program development, Jet Propulsion Laboratory, California Institute of Technology 695
John E. Hanson, program manager for space and military reactor programs, Los Alamos National Laboratory 705

Appendix: Supplemental questions and answers received from:

Los Alamos National Laboratory 721
Department of Energy 734
National Aeronautics and Space Administration 754
Defense Advanced Research Projects Agency 763

March 9, 1983:

Shelby T. Brewer, Assistant Secretary for Nuclear Energy, U.S. Department of Energy; accompanied by T. A. Werner, Director, Office of Converter Reactor Deployment, DOE; and Frank Coffman, staff member, Three-Mile Island 774
Richard F. Walker, president, Public Service Co. of Colorado, and chairman, Gas-Cooled Reactor Associates 794
Harold M. Agnew, president, GA Technologies, Inc 801
Robert B. Richards, general manager, Advanced Reactor Systems Department, Nuclear Fuels and Special Projects Division, General Electric Co 836
Robert E. Uhrig, vice president, Florida Power & Light Co 843
William M. Jacobi, general manager, nuclear fuel division, Westinghouse Electric Corp., Pittsburgh, Pa 853
Charles W. Pryor, manager, nuclear fuel services department, Babcock & Wilcox Co., Lynchburg, Va.; accompanied by J. Barclay Andrews III, manager, fuel engineering, nuclear fuel division, Babcock & Wilcox Co 863
Robert C. Arnold, president and chief operating officer, GPU Nuclear Corp., Middletown, Pa.; accompanied by Bahman K. Kanga, director, unit 2, Three-Mile Island; and John G. Graham, treasurer, General Public Utilities Corp., Parsippany, N.J 936
Ray C. Mairson, president, West Valley Nuclear Services Co., Inc., Westinghouse Electric Corp., accompanied by Samuel A. Scheer, manager, project control, West Valley Nuclear Services Co., Inc 980

Appendix: Supplemental questions and answers received from:

West Valley Nuclear Services Company, Inc 985
The Department of Energy 996
Testimony submitted by Combustion Engineering, Inc 1008
Letter from Exxon Nuclear Company, Inc. containing written comments for the hearing record 1012
Statement from the Institute of Nuclear Power Operations 1014

Supplemental questions and answers received from:

Westinghouse Electric Company 1020
Babcock & Wilcox 1025
Additional supplemental questions and answers received from the Department of Energy 1032

1984 DEPARTMENT OF ENERGY AUTHORIZATION

MONDAY, FEBRUARY 22, 1983

House of Representatives,
Committee on Science and Technology,
Subcommittee on Energy Research and Production,
Washington, D.C.

The subcommittee met, pursuant to call, at 9:30 a.m., in room 2325, Rayburn House Office Building, Hon. Marilyn Lloyd Bouquard (chairman of the subcommittee) presiding.

Mrs. Bouquard. The subcommittee will come to order.

Gentlemen, let me welcome you here this morning to the first Energy Research and Production Subcommittee hearing on the DOE fiscal year 1984 budget request. I want to welcome the new Members to the subcommittee: Mr. Hall, Mr. Valentine, Mr. Walker, and Mr. Chandler; and those who were Members during the last Congress: Mr. Roe, Mr. Lundine, Mr. Ottinger, Mr. Lujan, and Mr. Lowery.

I believe that this first budget of the 98th Congress offers us a genuine opportunity to provide the nuclear program with a fresh perspective and, as a result, gain increasing support throughout the Congress. There are some major changes since the last DOE budget was submitted to us which should be brought to the attention of the subcommittee.

First, after much blood, sweat, and tears, we achieved passage of the Nuclear Waste Policy Act of 1982. Not only does this law confirm the country's resolve to manage the nuclear waste problem, but it provides the authority to move the financial burden for such activity to the utilities who generate the waste.

In the breeder reactor program, I am heartened to see the DOE demonstrating a fresh emphasis on achieving better breeder economics through low-cost designs for a future prototype plant. I am also heartened by the resolve of the DOE and the utilities to innovatively explore alternative financing for Clinch River.

We will be hearing on that topic at a special subcommittee hearing once the March 15 preliminary report is available. I believe that this committee also has a responsibility to look at the potential research, development, and technology demonstration possibilities for the Barnwell plant. Our province is R&D and if very worthwhile R&D can be done there with minor modifications. I believe we must assess the facility's relative merits in the national interest.

Finally, in the converter reactor programs, I am disappointed that the OMB has zeroed funding for the HTGR program. I believe it is time for concrete action and a serious hardware-oriented thrust in that program which retains strong committee support.

Mrs. **Bouquard**. When Mr. Walker comes in, we will insert his statement.

[The opening statement of Mr. Walker follows:]

OPENING REMARKS OF REPRESENTATIVE ROBERT S. WALKER
FEBRUARY 22, 1983

GOOD MORNING. I, TOO, WOULD LIKE TO JOIN THE CHAIRMAN IN EXTENDING A WARM WELCOME TO OUR WITNESSES TODAY. THIS HEARING MARKS THE START OF OUR SUBCOMMITTEE HEARINGS IN THE 98TH CONGRESS AND WE ARE ALL LOOKING FORWARD TO A BUSY YEAR.

SINCE I HAVE TAKEN UP A NEW POSITION IN THIS CONGRESS, AS THE RANKING MINORITY MEMBER OF THIS SUBCOMMITTEE, PERHAPS I SHOULD TAKE A MOMENT TO INDICATE WHAT MY VIEWS AND INTERESTS WILL BE DURING THE COURSE OF THE NEW CONGRESS.

ONE OF THE MOST STRIKING PARTS OF OUR AMERICAN SYSTEM ARE THE CHECKS AND BALANCES WHICH THE FOUNDING FATHERS BUILT INTO THE SYSTEM. IT IS AN OLD TRUISM THAT THE EXECUTIVE PROPOSES BUDGETS, AND THE LEGISLATURE DISPOSES. THAT IS ONE OF THE FUNDEMENTAL STRENGTHS OF THE SYSTEM.

MY OWN VIEW OF THE BUDGET SYSTEM IS THAT THERE SHOULD ALWAYS BE AN ADVERSARIAL RELATIONSHIP BETWEEN CONGRESS AND THE EXECUTIVE REGARDLESS OF WHICH PARTY MAY CONTROL EITHER THE WHITE HOUSE OR THE CONGRESS. I HAVE YET TO SEE A BUDGET WHICH WAS PERFECT. MOST REPRESENT A WISH LIST WHICH SHOULD BE TRIMED IN SOME AREAS AND REDIRECTED IN OTHERS. I EXPECT THAT WILL ALSO BE TRUE THIS YEAR.

WE WILL EXAMINE THIS BUDGET WITH GREAT CARE. THERE ARE A NUMBER OF MAJOR DECISIONS WHICH WILL HAVE TO BE MADE DURING THE COURSE OF OUR DELIBERATIONS, AND WE WILL USE THESE HEARINGS TO GATHER SUFFICIENT INFORMATION TO BASE THOSE DECISIONS ON.

I SHOULD SAY THAT THERE IS ONE ITEM OF MAJOR INTEREST TO ME AS AN INDIVIDUAL, AND THAT IS THE PROBLEM AT THREE MILE ISLAND. WHILE TMI IS NOT IN MY CONGRESSIONAL DISTRICT, IT IS VERY NEAR. AND MOST OF THE DECISIONS WHICH ARE MADE CONCERNING THE CLEAN-UP THERE WILL HAVE A MAJOR IMPACT ON MY ~~CONSTUENCY.~~ constitueny,

THOSE OF US IN PENNSYLVANIA WHO HAVE LIVED WITH THE TRAGEDY OF TMI FOR NEARLY FOUR YEARS FEEL THAT NOT ENOUGH HAS BEEN DONE BY EITHER THE GOVERNMENT OR THE NUCLEAR INDUSTRY TO RESOLVE THE REMAINIG PROBLEMS.

ONLY LAST MONTH I HAD THE OPPORTUNITY TO DISCUSS THE CLEAN-UP WITH THE JAPANESE AND FOUND A WILLINGNESS ON THEIR PART TO CONTRIBUTE AND BE INVOLVED IN THE EFFORTS AT TMI. BECAUSE OF MY DISCUSSIONS, IT NOW LOOKS AS IF SOME AGREEMENT MAY BE REACHED IN THIS MATTER.

I BELIEVE THAT THE REASON THAT THE JAPANESE ARE WILLING TO MAKE THAT CONTRIBUTION IS THAT THEY SEE THE TMI TRAGEDY AS A MAJOR OPPORTUNITY TO LEARN ABOUT THE CONSEQUENCES OF AN ACCIDENT AND THE PROBLEMS ASSOCIATED WITH THE CLEAN-UP. THAT SAME OPPORTUNITY EXISTS FOR BOTH THE GOVERNMENT AND FOR THE AMERICAN NUCLEAR INDUSTRY. I HOPE TO BE ABLE TO CONVINCE BOTH THAT FAILURE TO FULLY EXPLOIT THAT OPPORTUNITY WOULD BE TERRIBLY SHORT SIGHTED.

Mrs. **Bouquard**. We are happy to have with us today as always, Dr. Shelby Brewer, who is certainly a friend of this committee, Assistant Secretary for Nuclear Energy in the Department of Energy. He is accompanied by Mr. Gordon Chipman, certainly no stranger to the committee, and Mr. Kermit Laughon. We are also happy to see Steve Lanes and other members of the staff formerly associated with this committee. So we want to welcome all of you that are here today.

Dr. Brewer, you may proceed with your testimony.

STATEMENT OF SHELBY T. BREWER, ASSISTANT SECRETARY FOR NUCLEAR ENERGY, DEPARTMENT OF ENERGY

Mr. **Brewer**. Thank you, Madam Chairman. I have a rather lengthy prepared statement I would like to offer for the record and then speak briefly, providing an overview.

Mrs. **Bouquard**. Without objection your complete statement will be made a part of the record. You may proceed as you wish.

Mr. **Brewer**. The budget that I am proposing today reflects our attention to a few major objectivies rather than an endless research and development program in a multitude of areas. Our purpose is not to perpetuate R&D, but instead, to perform developmental work which is beyond the institutional capability of the private sector, and to move it to the private sector expeditiously where the technology can live or die in accordance with commercial merit.

Our purpose is to focus sharply and drive relentlessly toward a few national imperatives. The agenda that we have laid out for your consideration holds no surprises, Madam Chairman. It is the continuation of the four-point policy which President Reagan articulated in October 1981: first, to resolve the institutional and regulatory crisis that faces the light-water industry, to support commercial reprocessing, to resolve the waste management problem, and to proceed expeditiously with breeder demonstration.

Madam Chairman, before I discuss the fiscal year 1984 request I would like to highlight some accomplishments since I appeared before you last year. We have made substantial progress, I believe, on the President's policy objectives of October 1981. Perhaps the most notable achievement of Congress and the executive branch was passage of the Nuclear Waste Policy Act of 1982. You, Madam Chairman, Mr. Ottinger, and other leaders in the House are to be complimented for your key roles in gaining passage of this landmark legislation.

As you know, the bill establishes a schedule and an institutional process for deploying a comprehensive high level waste storage and disposal system. It also moves the funding mechanism off budget and burdens the users of nuclear power rather than the general taxpayer.

In response to this legislation we have taken steps to establish the waste disposal fund, to establish contracts with the utilities by July, to begin the process of identifying potential sites for the process of winnowing these options to one site later in the decade. And responsive to the legislation, we have established a project office reporting to the Secretary to manage implementation of the act.

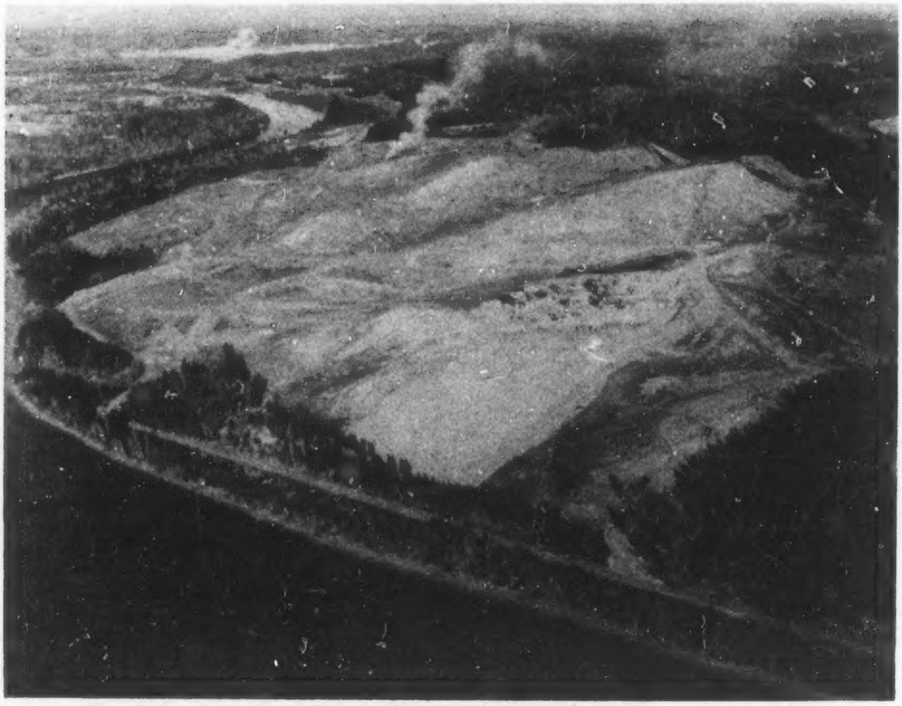
DOE's Bob Morgan of Savannah River will be testifying before you later on this subject.

Incidentally, we have begun preparation for the first repository exploratory shaft at Hanford. Slide 1 is a picture of the starter hole in the Hanford area at the basalt geological formation in Hanford. As you know, the President has endorsed completion and operation of Clinch River. When I appeared before you last year we had not yet begun work on the site for the project. We had promised to shave time and expense off the front end of the schedule, but we at that time, I believe it was in March, had not gained NRC permission to start.

I am happy to report that since that time we have started and nearly completed site preparation activities as shown in this slide.

ES STARTER HOLE

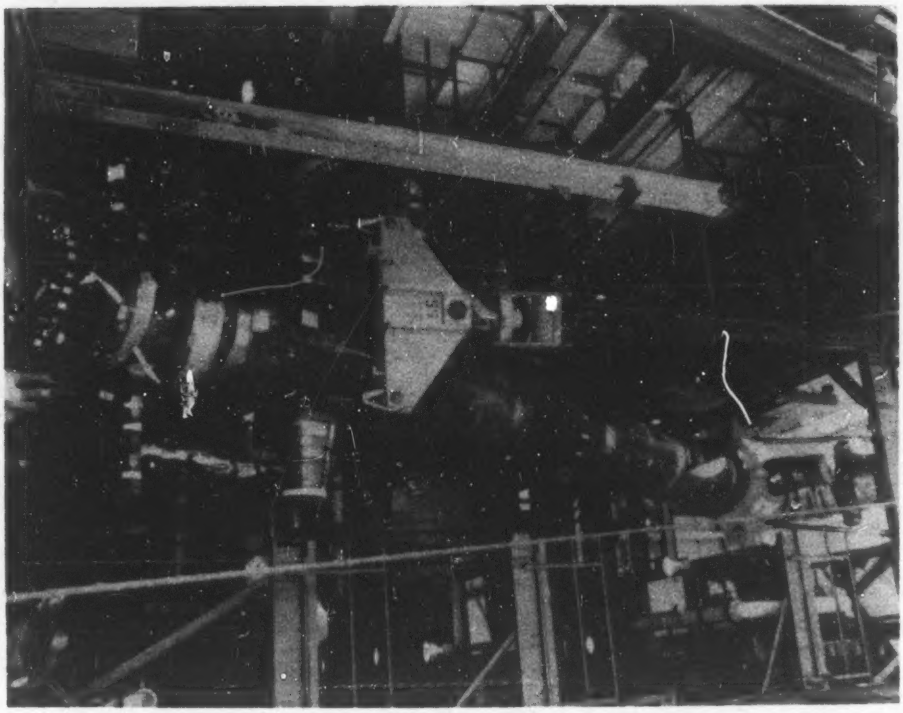
Slide 1



Slide 2

Slide 2 shows the Clinch River site. You can see the cement plant which is being installed. The safety and environmental reviews within NRC are proceeding very well. We expect to have a full construction permit later this year. There were other Clinch River accomplishments this year. We succeeded with the steam generator procurement and achieved a fixed cost contract for the nine-plant unit at a cost of about one-third of the cost of the prototype.

The prototype, incidentally, was finished and is now under test, as shown in this figure.



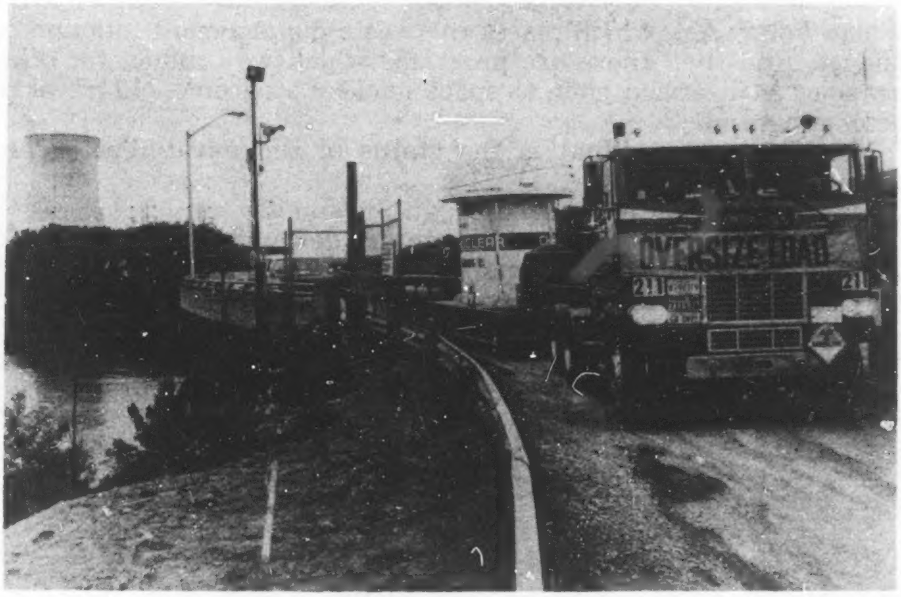
Slide 3

Slide 3 shows the steam generator being installed at the test stand in California.

Another element of the President's civilian nuclear policy is the objective of streamlining and stabilizing the nuclear licensing process without a reduction in safety to the public. The safety record of civilian power facilities is excellent, but the uncertainty attending the licensing process has been a major factor in driving off commercial investment. We have prepared legislation to stabilize the licensing process and will shortly be sending it to Congress.

Madam Chairman, there are a number of other past-year accomplishments not so directly related to the President's civilian nuclear policies as these, and I would like to simply mention them.

On TMI as you know our policy is to conduct R&D of generic benefit and to perform work where we have responsibility or capability to handle unique wastes. We do not have responsibility, nor do we seek it, for accepting on the part of the taxpayers the financial burden of the cleanup. We now have half of the waste off of the site.



Slide 4

In slide 4 you see a transporter containing a liner coming off of the island enroute to Hanford, Wash. As you know, Madam Chairman, we have lost our position in the foreign market for enrichment services since 1973 when we had 100 percent of the world market. We are now down to about 30 percent. We have in the past year made progress in recovering our position.

For example, we obtained a contract of more than $1 billion with Egypt for supplying enrichment services. We have taken steps to prove to our customers and potential customers that our prices will be as low or lower in the long term as the competition.

We are pressing ahead with the gas centrifuge project at Portsmouth. We began during the past year the test frame test at the test centrifuge facility at Oak Ridge. We made, last April, a very technically and politically difficult decision to concentrate our R&D effort on the atomic vaporizer process and advanced centrifuge. Further, to provide more flexibility for our customers and more stability for our own enrichment strategic planning, we have proposed a new contract form.

I think now, Madam Chairman, I would like to get to the fiscal year 1984 budget request. I would like to begin by placing it into the perspective that I believe that it deserves. The programs which I manage are of several types. They are programs which have to do with national defense, such as the naval reactors programs. They are programs which are operational in character as opposed to developmental. Enrichment is such a program, where we run the program, or try to, like a business.

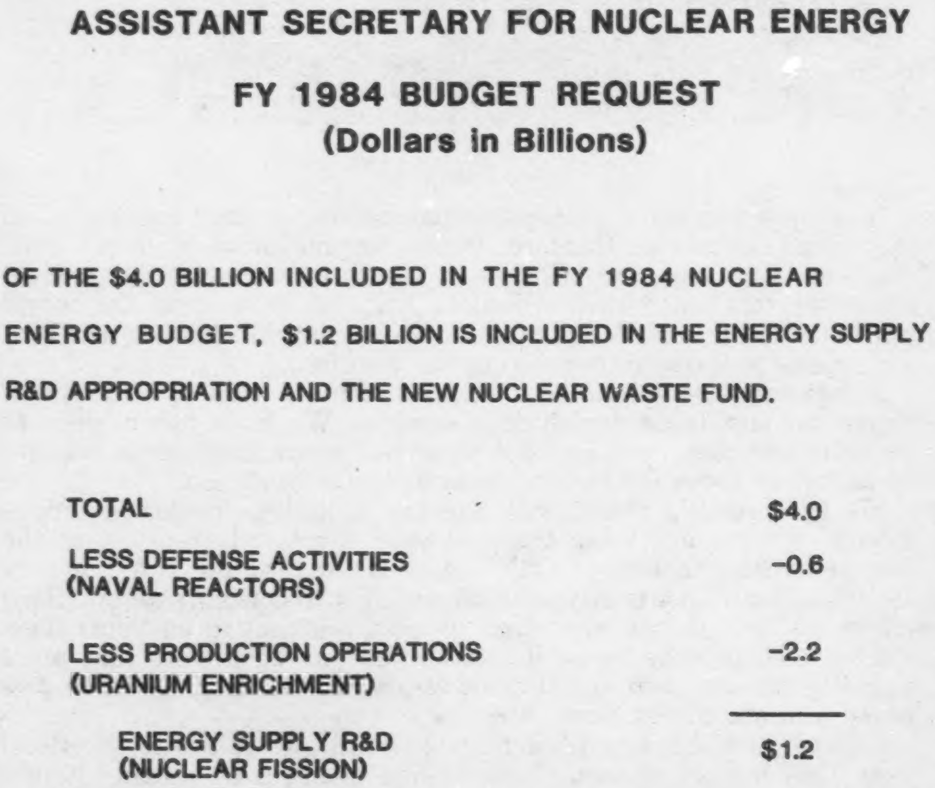
There are programs which have a special legislative basis, such as remedial action programs. Another example is the high level waste program under the recent legislation, the 1982 Nuclear

Waste Policy Act, which places the waste management function off budget. And then there are programs which we conduct for other agencies as a service, such as space nuclear programs and naval reactor programs.

Mrs. **Bouquard**. What is the status of the naval reactor program? In this budget?

Mr. **Brewer**. Let me walk through the slides.

Finally, there are programs which are developmental, relating to civilian nuclear systems which have the potential for commercial application, but which are presently beyond the private sector's ability to finance but which, in fact, promise enormous payback to the society. These are the programs which reflect policy choices of the administration and Congress, and are subject to intensive debate.



ASSISTANT SECRETARY FOR NUCLEAR ENERGY

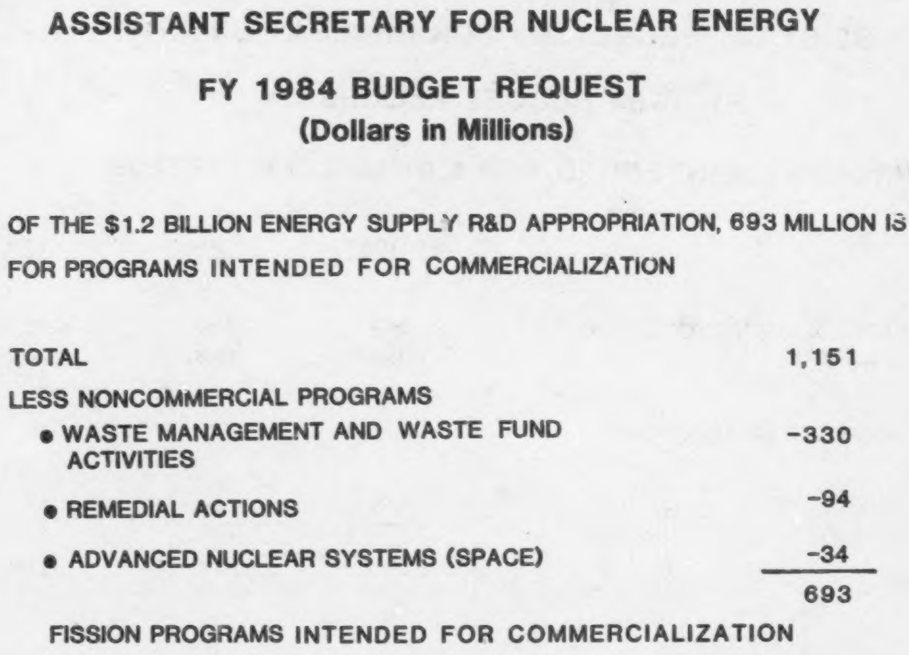
FY 1984 BUDGET REQUEST
(Dollars in Billions)

OF THE $4.0 BILLION INCLUDED IN THE FY 1984 NUCLEAR ENERGY BUDGET, $1.2 BILLION IS INCLUDED IN THE ENERGY SUPPLY R&D APPROPRIATION AND THE NEW NUCLEAR WASTE FUND.

TOTAL	$4.0
LESS DEFENSE ACTIVITIES (NAVAL REACTORS)	−0.6
LESS PRODUCTION OPERATIONS (URANIUM ENRICHMENT)	−2.2
ENERGY SUPPLY R&D (NUCLEAR FISSION)	$1.2

Slide 5

As shown in slide 5, the total nuclear budget—and these are round figures—is about $4 billion. That includes the naval reactors program of about $600 million, and the enrichment production operations of about $2.2 billion. If you deduct those two items the result is $1.2 billion for the energy supply R&D and nuclear fission. Incidentally, I would like to point out that the enrichment cost stream is matched in this budget by the revenue stream exactly, so that there is no net appropriation.



ASSISTANT SECRETARY FOR NUCLEAR ENERGY

FY 1984 BUDGET REQUEST

(Dollars in Millions)

OF THE $1.2 BILLION ENERGY SUPPLY R&D APPROPRIATION, 693 MILLION IS FOR PROGRAMS INTENDED FOR COMMERCIALIZATION

TOTAL	1,151
LESS NONCOMMERCIAL PROGRAMS	
• WASTE MANAGEMENT AND WASTE FUND ACTIVITIES	-330
• REMEDIAL ACTIONS	-94
• ADVANCED NUCLEAR SYSTEMS (SPACE)	-34
	693

FISSION PROGRAMS INTENDED FOR COMMERCIALIZATION

Slide 6

Mr. BREWER. As indicated on slide 6, of the $1.2 billion, energy supply R&D, there are three other accounts which I would like now to deduct. The waste management and waste fund activities of $330 million for fiscal year 1984, the remedial actions program and the space nuclear program. So what is remaining after all of that is $693 million, which can be appropriately considered to be civilian nuclear power development programs with commercialization potential, but subject to conscious policy choices of Congress and the administration.

ASSISTANT SECRETARY FOR NUCLEAR ENERGY

FY 1984 BUDGET REQUEST

PROGRAMS INTENDED FOR COMMERCIALIZATION

	FY 1982	FY 1983	FY 1984
BREEDER REACTORS (CRBR)	642 (194)	550 (194)	603 (270)
CONVERTER REACTORS	95	79	53
FUEL CYCLE	53	43	37
TOTAL	790	672	693

TOTAL PROGRAM REDUCTION ('82 to '84) = 12 PERCENT

REDUCTION OF PROGRAMS OTHER THAN CRBR = 29 PERCENT OVERALL, 11 PERCENT FY '83 TO '84

TOTAL INCREASE FROM '83 TO '84 = 3 PERCENT

Slide 7

You will note in the chart—slide 7—that we are down about 12 percent from 1982. In 1982 the total was $790 million. In the fiscal year 1984 request the figure is $693 million. So the point is that the civilian nuclear R&D budget is level or declining overall. As shown on slide 8.

ASSISTANT SECRETARY FOR NUCLEAR ENERGY

FY 1984 REQUEST

SUMMARY

FY 1984 REQUEST FOR FISSION PROGRAMS INTENDED FOR COMMERCIALIZATION UNDER ENERGY R&D

- REPRESENTS LEGITIMATE LONG TERM, HIGH RISK, HIGH POTENTIAL BENEFIT R&D
- IS FOCUSED ON SEVERAL CLEARLY DEFINED MAJOR MISSIONS
- IS REDUCED 12 PERCENT COMPARED TO FY 1982 (ONLY 3% INCREASE COMPARED TO FY 1983)
- IS RESPONSIVE TO PRESIDENT'S NUCLEAR POLICY DIRECTIVE

Slide 8

The issues that I believe will dominate the congressional fiscal year 1984 season are those Reagan policy objectives which have yet to be installed or implemented, such as the nuclear licensing reform initiative, the resolution of the Clinch River issue, reprocessing at Barnwell and implementation of the Nuclear Waste Policy Act. We had a very busy and productive year last year. I expect the nuclear agenda for fiscal year 1984 will be no less contentious this year.

I believe your invitation letter correctly lists the major issues.

I'll talk now about Clinch River. We face a major juncture in the project. As we have asserted many times in the past year, a way must be found to get as much of the remaining cost as possible off budget and away from the annual appropriations cycle. Parenthetically I would add that this objective applies to everything else we are trying to accomplish. We will provide a report to Congress describing one or more off-budget concepts on March the 15. We will not provide to Congress financial concepts which are unrealistic and ephemeral. Our utility partners have formed a task force of the best financial brains in the business, and we have provided guidance on the general target range in off-budget performance. And I would like not to prejudice their efforts with an elaborate discussion today of what they are considering.

On the breeder base program, Mr. Chipman will have more to say later today. The breeder base program has two missions. No. 1, to provide basic research and development and testing required to support the plant scale-up sequence, FFTF, Clinch River and beyond. And, second, to provide the intrinsic state-of-the-art content of commercial plants beyond Clinch River. We are attempting to projectize the base technology program and to give it relevance to today's projects and tomorrow's, and to make it less of a technological hobbyshop.

We are attempting to reduce its costs and to make it a profit center, if you will. Far too often we have given away our technological strengths to other countries. We are attempting to direct the base program to R&D and testing which will support major cost reductions in future breeder reactors—to be innovative, not rote, in our engineering.

Mr. Laughon will have more to say about the central rationale for light-water reactor fuel reprocessing in the civilian U.S. nuclear strategy. We have been charged with the task of creating a stable policy and regulatory environment in which reprocessing will occur by normal market forces in the private sector. We have not accomplished this task yet. We have considered with industry innumerable options and scenarios, but this has not been reduced to specific negotiations. And time is running out if Barnwell is to be the vehicle.

Our problem is in dealing with suggestions and formulations in the abstract. We need a definitive proposal to operate on, and we need it soon. We are hopeful in that regard, that a proposal from the private sector will be forthcoming in the weeks ahead.

As I pointed out before, the major achievement of the 97th Congress was passage of the Nuclear Waste Policy Act of 1982. Mr. Morgan will be reporting to you in the near future on progress in implementing this act.

Madam Chairman, I am very concerned about the U.S. position in the world enrichment market. As you know, we have gone, since 1973, from 100 percent of the world market to about 30 percent. Since 1973 Urenco, Eurodif, and the USSR have entered the market and have been quite successful. More recently I have been concerned about hairline cracks in our U.S. domestic market. My belief is that we are suffering some underlying structural deficiencies in the way we market, price, and contract for enrichment services.

We have some apparent rigidities in our system of doing business which our competition does not suffer. A fundamental phenomenon in the enrichment market for the next decade is that we and our competition will be competing against a massive world inventory of SWU's, an inventory that can undersell production unless we are very, very innovative.

Innovative pricing and marketing has not been the rule of the day in the past. In the next few weeks I will be announcing the formation of a small number of specialists to render Mr. Voigt and me advice on enrichment market strategy with an objective of securing the most favorable terms under the law for our U.S. domestic customers.

This concludes my formal statement. My colleagues—Mr. Chipman and Mr. Laughon—and I will be pleased to answer whatever questions you may have at this time.

Mrs. BOUQUARD. Thank you very much, Dr. Brewer. It was certainly heartening for me, the first time I can remember since I have chaired this subcommittee, that we could have a progress report and actually see signs that we are making progress within the research and development that has been conducted in this past year.

I want to congratulate you for your outstanding efforts and for your very positive approach to addressing our nuclear research and development program, as you have done.

Mr. Chipman and Mr. Laughon, are you going to sit with us?

Mr. **Chipman**. We will be speaking separately, ma'am.

Mrs. **Bouquard**. Mr. Laughon, I understand, is going to be next. I believe that is correct. Of course, I am very interested in our uranium enrichment problem, how we have gone from 100 percent to about one-third of the world's market. I was happy to know that you are going to be giving us a statement on our plans.

What do you really think our prospects for regaining our share of the world's market are?

Mr. **Brewer**. I think they are very good, Madam Chairman. We are, as you know, proceeding with the gas centrifuge project at Portsmouth. That offers a major cost advantage over diffusion generated enrichment. I am hopeful that we can regain the market which we have lost abroad, and some of the domestic market which is now under attack from abroad.

Mrs. **Bouquard**. Certainly, members of this committee warned the previous administration this was going to happen, that we did not have a corner on the market for uranium enrichment. We have certainly seen this happen. We did say that this would be a reality and would certainly have an adverse effect on our balance of payments.

Going back to our T&E facility on nuclear waste, what are the present plans for a T&E facility? Basically, would you discuss the pros and cons of the colocation of the facility versus a separately sited facility?

Mr. **Brewer**. Madam Chairman, could I defer that question to Mr. Morgan, who is in charge of that program now. He will be before you, I believe, later this week or early next week.

Mrs. **Bouquard**. We will talk to Mr. Morgan in detail about that. I was rather puzzled that the administration did not request any fiscal year 1984 funds for the HTGR program. I personally feel there are commercial applications for the HTGR. Are there reasons for that lack of request of funds?

Mr. **Brewer**. As you know, the Department has endorsed the HTGR over the years for its unique features such as high temperatures which water reactors and liquid metal reactors cannot reach. In the budget environment that the administration found itself in preparing the fiscal year 1984 budget, the last chart I showed you, you will note that the budget was very tight, very squeezed down, and the priorities simply had to be made without the HTGR.

Mrs. **Bouquard**. But it seems to me that industry in the testimony last year indicated that there was a need for the commercial application for the HTGR, that this was a marketable technology.

Mr. **Brewer**. Yes. But you will recall several years ago, Madam Chairman, there was I believe in the omnibus legislation of 1982, a requirement that a definitive cost-sharing program or project be brought forward, and that if it was not forthcoming, that the HTGR would not win congressional funding in the future. A proposal has not been forthcoming.

Mrs. Bouquard. Thank you very much. I meant for us to abide by the 5-minute rule. Mr. Ottinger. Thank you very much, Dr. Brewer.

Mr. Ottinger. Well, I thank you, Madam Chairman. Since there are only two of us here, you are welcome to proceed if you want.

Mrs. Bouquard. I believe we have Mr. Valentine, also.

Mr. Ottinger. I am sorry. I had my nose in the paper, so I didn't see the late arrivals. I would like to join you in welcoming Mr. Brewer at the start of a new season. It being a new season, I just am gravely concerned——

Mrs. Bouquard. Mr. Ottinger, did you say new season, or open season?

Mr. Ottinger. New season. I think I wouldn't comment further. I am concerned at the enormous amount of the budget tied up in the breeder program, and I wonder what your view of the justification for this is in view of the fact that the world is awash with uranium, we are seeking to cut back on our uranium imports, the demand for electricity seems to be way down.

How are we going to use all this? The breeders are much more expensive than existing fission reactors. Isn't all this money going to be wasted?

Mr. Brewer. Mr. Ottinger, it is a question of timing, whether the breeder will be needed, and the lead time required to put that technology on the shelf and have it available if and when it is needed. The lead time to start with, is about 25 or 30 years when you consider that you need an intermediate demonstration such as the Clinch River size, and then a large prototype size plant before the utilities can order plants with technical and financial confidence.

The timing of the need, on the other hand, is quite uncertain, and my pencil simply is not sharp enough to tell you the year, the month, the day and the hour that we will run out of uranium and need to deploy the breeder, using the depleted tails at the enrichment plant.

Mr. Ottinger. Has any study been done to show when the need might occur?

Mr. Brewer. There are numerous studies, Mr. Ottinger. I could fill this room with the debate on that issue. We have studied that question continually I believe, since the late 1960's.

Mr. Ottinger. Well, there have been substantial increases in the availability of uranium the last few years. Do you adjust your program as those conditions change?

Mr. Brewer. We cannot turn the program on or off like a neon light in response to new estimates of the uranium resource base, or new nuclear electrical load growth projections. When Clinch River was authorized, I believe the nuclear electrical growth was estimated to be about 1,000 gigawatts in the year 2000, or thereabouts.

It is now substantially lower than that. On the other hand, the Clinch River project has slipped a number of years due to the policy debate from 1976 to the present. So, one thing has slipped, and another thing has slipped. And I still feel that the pace of the project as a national endeavor is about right from a prudent planning point of view, particularly since we have already invested so much in it.

Mr. **Ottinger**. Are your cost estimates for the Clinch River realistic? And I am particularly concerned in that respect, some questions you were asked recently in the Senate about where the plutonium would come from for Clinch River, and how the material would be reprocessed and how much that would cost, and whether that is in your estimate.

Mr. **Brewer**. I would like to ask Mr. Chipman to address that question in detail. The source of plutonium for Clinch River traditionally had been identified as the stockpile. And since the Government owns it, anyway, a charge is not made against the project.

Now, of course, if we take the project off budget, we will have to make an allowance for the entire fuel cycle cost, the fuel supply cost for Clinch River, since it will be more of a commercial undertaking.

Mr. **Ottinger**. Do you have an estimate for what that plutonium value is?

Mr. **Brewer**. I don't have it at my fingertips. I can certainly supply it for the record.

Mr. **Ottinger**. I would appreciate it if you would.

Mr. **Brewer**. Yes, sir.

[The information to be supplied for the record follows:]

DOE will obtain plutonium for producing CRBRP fuel for the 5-year demonstration period from the U.S. Government stockpile of plutonium or from other possible sources, such as foreign supplies or domestic power reactor spent fuel, should the private sector choose to develop LWR reprocessing. Plutonium for operation of the plant subsequent to the demonstration period may be obtained from various sources including reprocessing of spent breeder fuel, reprocessing of spent light water reactor fuel, or other sources. Any one of these sources, or a combination thereof, could be sufficient to fuel CRBRP during its lifetime. Each supply option, however, does bear some amount of uncertainty and DOE accordingly has not firmly committed to any single option for the operation of the CRBRP following the demonstration period.

The core assemblies removed from the CRBRP during the 5-year demonstration period will contain about 5 metric tons of fissile plutonium. DOE plans to use these assemblies in the reserch and development activities associated with breeder reactor reprocessing. Because Clinch River will be a net producer of plutonium and because DOE will retain possession of the plutonium. DOE feels it inappropriate to include plutonium as an element of the cost estimate. However, the project has carried a $10 million inventory charge in its cost estimate to account for the use of plutonium during the demonstration period.

There is an established world market for plutonium. Plutonium of the type used to fuel the CRBRP is currently selling for a market price of $4 to $6 per gram fissile.[1] The price is expected to stay in this range in the near future. Plutonium supply beyond the demonstration period will be addressed in the alternative funding report to be submitted to Congress on March 15, 1983.

Mr. **Ottinger**. What about the reprocessing? Where do you now contemplate that that would take place?

Mr. **Brewer**. Mr. Ottinger, could I ask Mr. Chipman to come to the table?

Mr. **Ottinger**. Well, he is going to testify?

Mr. **Chipman**. Yes, I am.

Mrs. **Bouquard**. I believe your 5 minutes are up.

Mrs. **Bouquard**. We would like to welcome our new member, Mr. Chandler. Do you have any questions?

Mr. **Chandler**. No, thank you, Madam Chairman.

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[1] Nuclear Assurance Corporation Report, Near-Term Plutonium Market, March 1983.

Mrs. **Bouquard**. Our other new member, Mr. Valentine, we are happy to have you with us today. You may proceed.

Mr. **Valentine**. Thank you, Madam Chairman.

Dr. Brewer, are you able to tell us what proportion of the cost of this Clinch River project is anticipated to be the responsibility of private sector?

Mr. **Brewer**. The cost to go on with Clinch River is about $2.2 billion. That plus the sunk cost, about $1.4 billion equals the current cost estimate, or numbers thereabout. I cannot tell you with precision the portion of the $2.2 billion that we anticipate will be forthcoming from the private sector. The utility task force is hard at work. I would not like to prejudice their results, their conclusions, their recommendations or their proposals by discussing it.

Mr. **Valentine**. Then you would prefer not to say whether the figure that has been suggested is, in your opinion, the energy industry's fair share of the cost of this, because they will eventually profit, so to say, from this tremendous outlay of tax dollars, and then sell this product to heat homes, hopefully, in the Second District of North Carolina and elsewhere in the country.

But are you in a position to say whether, or to have or express an opinion as to what you think should be the participation of the Carolina power companies and Duke power companies and so on?

Mr. **Brewer**. No, sir. I will say that the maximum one might expect from the private sector would correspond to the minimum further Federal outlay. If you consider or assume that the termination cost of the project to the Government would be about $300 million, one could assume that the Government would see fit to contribute another $300 million rather than pay for termination costs.

In that case, a major proportion of the costs would have to be forthcoming from the private side. That would be about $1.8 billion or $1.9 billion.

Mr. **Valentine**. Thank you very much.

Mr. **Brewer**. Yes, sir.

Mrs. **Bouquard**. Thank you very much, Mr. Valentine.

Mr. Brewer, what progress has been made at strengthening our foreign nuclear R&D activities? Do you really see the prospects for increasing our foreign participation and cooperation as we have seen in the past for our endeavors in developing our nuclear engineering option? Do you really see that we have some policy issues or problems that we need to address this year?

Mr. **Brewer**. That is proceeding well, Madam Chairman. We are, for example, engaged in joint programs with other countries such as the United Kingdom, France, Japan. I would like to push those programs more toward definable projects, rather than simply exchanging people and data, and to put them into more of a commercial, business-like mode.

I feel that in the past we have lost a lot of our technology to other countries by being too loose and free with it.

Mrs. **Bouquard**. Do you think that we are regaining our accountability, our credibility in cooperative efforts with our partners?

Mr. **Brewer**. Our credibility as a supplier is on the increase. I would cite, for example, the case of Mexico, where at one point American vendors were not even on the scoreboard. At the point in time when the Mexican Government withdrew from the nuclear bidding process, we were close to the top. We were at the top.

Mrs. BOUQUARD. I have a question on another area. In our continuing resolution for fiscal year 1983, we added about $25 million to the LMFBR base program to support efforts by the national laboratories and to take care of some of the personnel reductions. What efforts has the Department made to address the intent of Congress in this matter?

Mr. BREWER. We have, Madam Chairman, displayed in our budget table the fiscal year 1983 column of the fiscal year 1984 budget. We have also provided a complete laboratory and state table which crosswalks the budget into the laboratories, et cetera.

My impression is that the 1983 columns generally are either flat with 1982, or perhaps 5 percent decreased from 1982.

Mrs. BOUQUARD. But there is a slight decrease?

Mr. BREWER. It is my impression that there is. I would like Mr. Chipman to address that in more detail. But under that, the breeder base program was cut about $125 million in the President's request for 1983. In the continuing resolution, or the administration's interpretation of the continuing resolution, another $35 to $40 million was added back, leaving a total cut of about $85 or $90 million in the breeder program. So, the figures are down from 1982.

Mrs. BOUQUARD. Thank you very much. Mr. Ottinger.

Mr. OTTINGER. I am concerned about your elimination of the extended burnup program for existing reactors. What is your rationale for that?

Mr. BREWER. Mr. Ottinger, the high burnup program deals with a technology which in fact is in the marketplace. In addition to the extreme budget constraints, it was felt that it was not appropriate to continue research and development work on a machine that was already commercialized.

Mr. OTTINGER. Taking the rug out in the midst of contracts that are being pursued is certainly going to be disruptive to the program. And on a cost-benefit basis, it is a much more advantageous program than the breeder and other programs that you are pursuing.

Mr. BREWER. Taking the rug out—an excellent example of that is the Clinch River project.

Mr. OTTINGER. This program makes sense on a cost-benefit basis. There is dispute as to whether Clinch River does. But here is a program that will permit your existing fission reactors to use their existing fuel 20 to 30 percent more efficiently, reduce the quantity of waste by some 40 percent. I don't see why the Department doesn't have a high priority on that. It would make existing reactors far more economic at a time when the industry is being seriously threatened.

Mr. BREWER. Mr. Ottinger, I believe that at least one of the reactor manufacturers is already offering fuel and warranties for that fuel up to about 40,000 megawatts per metric ton. If that is the case, why should the Federal Government, using taxpayers' dollars, be trying to replicate or repeat that?

Mr. OTTINGER. Do you have testimony that the five manufacturers who are involved in this would in fact carry on without Federal funds?

Mr. **Brewer**. I have no such testimony, Mr. Ottinger. But what I am saying is that I know that at least one of the reactor manufacturers is now offering the commercial market fuel warranted to a burnup of approaching half of the target of the high burnup program of the Department of Energy.

Mr. **Ottinger**. I think it would be useful, we will be having hearings on it, to have that information specifically, how long it will retard the availability in the commercial sector of this technology. This seems like a very advantageous thing. The only reason I can think of not to pursue it is to try and keep the existing reactors inefficient to create a greater argument for breeders, which just seems nonsensical.

Mr. **Brewer**. Well, that is not the case, Mr. Ottinger. The need date for the breeder is only extended by about 5 to 7 years with that program, so it was not thought to be in competition with the breeder.

Mr. **Ottinger**. Is research being pursued, or are you planning to pursue any research, on new design for more efficient light water reactors that can, as we were told, produce, in a quantum jump, greater efficiency light water reactors for the future?

Mr. **Brewer**. We have no plans for a new light water converter reactor design at this time.

Mr. **Ottinger**. Why?

Mr. **Brewer**. There is no compelling rationale to do so, Mr. Ottinger, if we proceed with the breeder.

Mr. **Ottinger**. I was afraid that was going to be your answer. On a cost basis, how does the improved light water reactor compare with your estimates for the breeder?

Mr. **Brewer**. I would have to answer that for the record.

Certainly the breeder, in its initial phases of deployment, will have a bus bar cost disadvantage because of its higher capital costs. We are working very diligently to find ways of reducing the breeder capital costs in comparison with the light water reactor.

I would like to provide for the record a comparison of the LMFBR capital, fuel and O&M costs versus the similar categories for what I think you are referring to, the advanced light water reactor designs that were considered several years ago.

Mr. **Ottinger**. I would appreciate that.

Mr. **Brewer**. We would be happy to supply that.

[The information follows:]

ESTIMATED LIFE CYCLE LMFBR AND PWR GENERATING COSTS

[Mills/per kwh in 1982 dollars]

Cost element	Current PWR [1]	Advanced light water reactor [1]	EED B LMFBR [2]
Capital	23–41	23–41	26–46
O&M	6–6	6–6	5–5
Fuel cycle	12–12	11–11	7–7
Total	41–59	40–58	38–58

[1] 3412 MWt PWR—1139 MWe at $1,300/per kW. Advanced Light Water Reacter (LWR) would achieve a 15 percent reduction in uranium requirements, primarily through the use of higher burnup fuel.

[2] 3800 MWt LMFBR—1457 MWe at 1,561/per kW.

Note.—Fuel cycle costs based on 2,001 startup for advanced LWR and for LMFBR. Capital cost range reflects uncertainty surrounding interest and escalation charges for future plants.

Sources: Energy Economic Data Base V (UE&C), 1982; Nonproliferation Alternative System Assessment Program Final Report, 1980.

Mr. **Ottinger**. On nuclear waste, are you planning to do an environmental impact statement out at Hanford?

Mr. **Brewer**. I would ask you, Mr. Ottinger, to address that question to Mr. Morgan who will be here later this week.

Mr. **Ottinger**. What are your plans for Barnwell?

Mr. **Brewer**. Our plans for Barnwell. As I said, the time is running out on Barnwell. There is funding provided through July 30, and no further. We have great difficulty dealing with the problem in the abstract. We need a specific proposal from the private sector on Barnwell, something that we can consider and operate on.

We do not have such a proposal at this time, although there are groups intending, I believe, to approach the Department later this spring.

Mr. **Ottinger**. Thank you.

Mrs. **Bouquard**. Thank you.

Mr. Chandler, I believe you had a question at this time?

Mr. **Chandler**. Yes. Thank you. Lots of them.

I would like to ask you about the high temperature reactor program that we were just reviewing in the body of your text here. That is, I think we all understood, as you talked a while ago, about why there is no light water reactor demand right now, there isn't the demand for the power. I am wondering, is there some other application for this technology?

I would like you to comment on that, if continuing this isn't just absolutely foolish, or if there is a useful purpose for it.

Mr. **Brewer**. There are a number of unique applications of the HTGR, applications which, as I said light water and liquid metal reactors cannot reach.

HTGRs offer the prospect, for example, of direct cycle cooling. They offer the Brayton cycle, which requires little or no cooling water, only a dry heat exchanger.

They offer the prospect of heating. They offer the potential of a synfuels application.

One can reduce the throughput requirement for coal by about one-third, if you are converting coal to a synfuel. You can reduce the mining requirement by about one-third if you use a gas reactor as the heat source, rather than coal itself.

So it has many diverse applications associated with its high temperature feature which other reactors do not enjoy.

Mr. **Chandler**. Thank you.

Mrs. **Bouquard**. Thank you.

I would like at this time to recognize the ranking minority member of our committee. Mr. Walker, we are happy to have you as a member of this committee, serving a very important role on this committee.

We certainly would like to recognize you at this time.

Mr. **Walker**. Thank you very much, Madam Chairman.

I don't have any questions at this time, but I would have some opening remarks that I would appreciate an opportunity to make a part of the record.

Mrs. **Bouquard**. Without objection, it will be made a part of the record as previously stated.

Thank you very much, Dr. Brewer. We look forward to working with you this year.

Mr. **Ottinger**. Madam Chairman, I would like unanimous consent to be able to submit some written questions to Dr. Brewer.

Mrs. **Bouquard**. Without objection, they will be made a part of the record if you would submit them to Dr. Brewer. They will be forwarded by the committee.

Mr. **Brewer**. Thank you, Madam Chairman.

[The prepared statement of Dr. Brewer follows:]

STATEMENT OF SHELBY T. BREWER
ASSISTANT SECRETARY FOR NUCLEAR ENERGY
DEPARTMENT OF ENERGY
COMMITTEE ON SCIENCE AND TECHNOLOGY
SUBCOMMITTEE ON ENERGY RESEARCH AND PRODUCTION
U.S. HOUSE OF REPRESENTATIVES
FEBRUARY 22, 1983

Madam Chairman and Members of the Committee, I am pleased to appear before you today to discuss the proposed Department of Energy fission energy budget. The FY 1984 funding request for nuclear programs is $837 million in budget authority. This compares to $760 million for FY 1983. Distribution of the funds among the program elements is as follows:

	FY 1983 (in millions)	FY 1984
Uranium Enrichment	$1,942	$2,240
Uranium Enrichment Revenues	-1,968	-2,240
Commercial Waste Management	18[1/]	16[1/]
Remedial Actions	63	94
Breeder Reactor Systems	550	603
Converter Reactor Systems	79	53
Fuel Cycle	37[2/]	37[2/]
Advanced Nuclear Systems	39	34
Total	$ 760	$ 837

[1/] Excludes $24 million in FY 1983 and $7 million in FY 1984 for activities now managed by the Nuclear Waste Policy Act Project Office.

[2/] Excludes $6 million in FY 1983 and $5 million in FY 1984 for activities now managed by the Nuclear Waste Policy Act Project Office.

Madam Chairman, the agenda that I am proposing for FY 1984 should hold few surprises for the Committee. Last year, when I appeared before you, I announced a realignment of my programs and organization to conform with and be responsive to the nuclear policy that President Reagan had announced in October of 1981. I also told you that I had introduced a "management-by-objective" approach into nuclear programs that allowed for concentration on major goals and elimination of work not directly related to the President's policy initiatives. As a result, we have made real progress toward meeting the President's policy objectives: specifically, waste legislation is in hand, Clinch River is progressing on an accelerated schedule, and we are ready to submit licensing reform legislation. In addition, notable progress continues at TMI, GCEP, and West Valley. Very recently a Memorandum of Understanding was signed by DOE, NASA, and Defense which provides a framework for our space reactor effort. These achievements demonstrate our resolve to produce results rather than engage in protracted study.

I would like to point out that the programs we have planned for FY 1984 are entirely consistent with the appropriate Government role in energy development as defined by the Administration. The elements of this role as applied to nuclear energy include:

- stabilizing Federal policy for time periods commensurate with the leadtimes required in nuclear development;
- removing unnecessary regulatory impediments that have developed over the years;
- fulfilling Federal responsibilities for certain elements of the fuel cycle, such as uranium enrichment; and
- conducting high-cost, high-risk, research and development that is of significant benefit to the Nation but beyond the current capability and resources of the private sector.

Before describing the program elements in detail, I would like to comment briefly on some of the highlights and issues in our nuclear program.

URANIUM ENRICHMENT

The actual cost to the taxpayer of the FY 1984 uranium enrichment program is zero. We expect to realize $2.24 billion in enrichment revenues which will completely offset the requested funds. Uranium enrichment has been an enterprise of the United States Government, dating back to the days when it was developed for defense purposes. Since that time, we have provided enrichment services to both domestic and foreign civilian customers.

Prior to 1974, the United States was the only enrichment supplier in the world market. Today the USSR and two consortia (URENCO and EURODIF) are our active competitors. By utilizing extremely aggressive marketing strategies, this competition has been able, in one decade, to reduce the U.S. share of the foreign enrichment market from 100 percent to about 30 percent. In addition, significant inroads are being made in our domestic enrichment sales. Our market performance in the future will depend primarily on our ability to offer low-cost enrichment services under favorable contract terms.

To meet this challenge, we are taking a number of actions which are designed to enhance the market position of the U.S. uranium enrichment program.

Specifically, steps are being taken to minimize the current selling price by reducing costs and optimizing enrichment production activities. Our success in this area is reflected in our announcement today that there will be no increase this year in the charge for enrichment services. A new enrichment contract, the Facility Requirements (FR) contract, is also under development to provide needed stability between enrichment commitments and actual requirements by offering greater contract flexibility to customers. Finally, advanced, low cost technologies are being developed and deployed on a schedule designed to make the most economically attractive enrichment services available to U.S. customers in the post 1990 time period.

Currently we are enriching uranium by means of the gaseous diffusion process. A far more cost effective process is gas centrifuge. In addition to providing separative work units (SWUs) at a significantly lower cost than is currently possible, the centrifuge process uses approximately 5 percent of the energy that gaseous diffusion consumes. We are constructing the Gas Centrifuge Enrichment Plant (GCEP) at Portsmouth, Ohio. Construction progress has been excellent and we expect the first increment of plant production to begin in 1989. A large fraction of the funds we are requesting for FY 1984 will go for GCEP construction. When considering the uranium enrichment request, one critical factor must be kept in mind. Without lower cost enrichment technology, the United States Government will price itself out of the multibillion dollar enrichment business.

Beyond centrifuge, we are developing the Atomic Vapor Laser Isotope Separation (AVLIS) technology which has the potential for additional cost savings and energy consumption advantages. Last spring this process was selected from three candidates for engineering development. While progress to date has been most encouraging, the AVLIS technology is not sufficiently mature to permit deployment before the mid-1990s.

Finally, I would like to point out that in FY 1984 we have decided to operate our gaseous diffusion plants at slightly higher power levels than in FY 1983. This will require the purchase of an additional 530 megawatts of power, which, incidently, will reduce demand charges for power not purchased. The increase in power is in response to recent technical studies which concluded that prolonged plant operations below design levels could incur risk of equipment failure. Continued operation at lower power levels also jeopardizes the Department's ability to meet scheduled customer deliveries in a timely manner.

WASTE MANAGEMENT

The progress made over the last year in the area of waste management is an accomplishment of which we can all be proud. With the passage of the Nuclear Waste Policy Act we have a basis in law for a sharply focused program and a definite schedule.

A key feature of the Act, as you know, was the establishment of a system of fees, paid by the utilities, to fund the waste programs that are directly related to commercial nuclear waste disposal. We have long felt that the beneficiaries of nuclear power should bear the cost of disposing of the waste. This transition from Government to commercial funding will impact the FY 1984 budget as offsetting revenues realized from fee collection are deposited in the Nuclear Waste Fund account. Programs not covered under the Waste Fund, such as Remedial Actions and the West Valley Demonstration Project, will remain a Federal funding responsibility.

Secretary Hodel has appointed Mr. Robert Morgan as the Director of the interim Nuclear Waste Policy Act Project Office and has detailed a sizable contingent of personnel to ensure that the near term legislated requirements are met. Preparations for establishing the office on a permanent basis are under way. I am confident that the Department will swiftly and effectively implement the Act. Mr. Morgan will be testifying regarding the details of the programs to be conducted under the Nuclear Waste Policy Act.

Included in the programs not covered under the Waste Act is the Department's responsibility for remedial actions at sites contaminated as a result of prior U.S. Government activities. Work is divided among four major programs. The Formerly Utilized Site Remedial Action Program (FUSRAP) has identified 35 sites throughout the country as requiring stabilization or removal of contaminated material. We are now performing the required work at the 14 sites for which DOE has remedial action authority. Our uranium mill tailings remedial action (UMTRA) program is directed toward the cleanup of 24 former processing sites and an estimated 5,000 to 6,000 vicinity properties contaminated by mill tailings from uranium mining and processing. A third program covers our participation in a Federal/State cooperative effort to remove uranium mill tailings used for construction purposes in Grand Junction, Colorado. At the close of FY 1984, we will have completed remedial actions at 612 of the 626 structures requiring attention. A fourth program manages and arranges for disposition of facilities formerly used for civilian nuclear energy development. About 80 sites are currently identified for work, including the Niagara Falls Storage Site, selected buildings at the Mound Facility in Ohio, and the Shippingport Atomic Power Station. This program is developing improved technology and methods for facility decontamination and decommissioning (D&D) that will be of substantial benefit to industry in retiring nuclear plants from operation.

Finally, we are conducting a demonstration of high-level waste solidification at the Western New York Nuclear Center, near West Valley. After solidification technology has been developed, we will oversee the D&D of the West Valley facility and direct disposal of the resulting wastes. Our solidification work at West Valley is coordinated with our generic Waste Treatment Program, which is developing the waste package technology for repository disposal.

BREEDER REACTOR SYSTEMS

Our breeder reactor request for FY 1984 shows a slight increase over the FY 1983 appropriation. A substantial fraction of that request is for the Clinch River Project. I am well aware that support for this Project is far from unanimous but without rehashing the arguments for and against its continued funding, I would like to review briefly the historical breeder strategy that incorporates CRBR as a necessary element.

In 1967, when we concentrated our efforts on a single breeder technology--the Liquid Metal Fast Breeder Reactor--several alternative developmental strategies were considered. The strategy that emerged as having consistently the best potential for both safety and economics was to build a series of plants of increasing size that could demonstrate the critical elements of component and plant development. This scaleup approach was used to develop the light water reactor for commercialization. It has also been the strategy of choice for all other nations actively developing a breeder option.

Two reactors in the scaleup series--EBR-II and FFTF--have been built and are operating. The Clinch River Plant, which is the last step before building a commercial-size plant, is moving toward the construction stage. The plant design, which is at the forefront of technological advance, is approximately 90 percent complete. More than 70 percent of the major equipment and components have been delivered or are on order.

The licensing process, resumed in September 1981, is proceeding exceptionally well. Last August NRC granted our request to begin site preparation and in September work was initiated. We have completed the site suitability and environmental requirements for licensing and we expect NRC to issue its Safety Evaluation Report in March. NRC authorization to begin safety-related construction activities is expected by November of this year. Overall, CRBR licensing is moving at a faster pace than that of any light water reactor over the past five years. We believe this performance attests to the technological sufficiency of the plant design.

Despite these technical achievements, the Clinch River Project and, as a result, the entire breeder program are facing a critical juncture. The technology is close to commercial viability, but the financial resources necessary to complete CRBR are in question.

Clinch River was conceived as a joint venture between Government and industry with each bearing an equitable share of Project costs. The original industry financial commitment to CRBR funding was based on a cost estimate derived in 1972. Since that time, a combination of factors, including inflation and costly delays from Federal policy changes, have sharply escalated Project costs. The once equitable industry commitment is no longer sufficient to balance the large outlays that the Government must make to complete the Project. As you know, CRBR funding was provided for FY 1983 with a requirement for a vigorous exploration of possible methods of reducing Federal budget outlays. In response, the utility industry has established a task force of senior financial executives to prepare proposals for greater industry cost-sharing in the Project. Recommendations are to be forwarded to the Congress by March 15, 1983. It is my hope that the commitment of the private sector to the Clinch River Project is such that viable financing arrangements will be forthcoming.

CONVERTER REACTORS

The Converter Reactor Program is directed toward improvements in the Light Water Reactor technology and resolution of regulatory, financial, and institutional problems adversely affecting the nuclear industry. In the first instance, we are serving as the coordinator of a DOE/NRC/industry cooperative program to develop a systematic and integral approach to LWR safety. This responsibility was established by the Nuclear Safety Research, Development, and Demonstration Act of 1980. We are also participating in an international cooperative program to improve reactor response to accident conditions, making use of the unique capabilities of the Loss of Fluid Test (LOFT) facility. As an extension of our technical safety activities, we are cooperating with NRC, the Electric Power Research Institute and General Public Utilities in the cleanup of the damaged TMI-2 reactor. DOE's role is to accept unique radioactive waste, including the damaged core, for research and development of generic value to increased reactor safety and reliability.

Our role of assisting in the resolution of problems currently hindering the LWR industry is in response to the President's directive. We have prepared recommendations for licensing and regulatory reform that we believe will better serve the interests of, first and foremost, the general public; secondly, the regulators; and third, the industry which designs, constructs and operates nuclear power plants. We intend to submit legislation early in this session of Congress.

FUEL CYCLE PROGRAM

The technical objective of our Fuel Cycle Program is to develop advanced technology for reprocessing of fuels. Efforts are focused on the more stringent requirements associated with reprocessing of fast breeder reactor fuel which has higher thermal and radiation burdens, higher fissile content, and sodium contamination. This technology will also be available for future LWR fuel reprocessors.

We continue to feel strongly that reprocessed fuel has significant advantages over disposal of spent fuel on the basis of fuel conservation, nonproliferation, environmental, and economic considerations. As you know, the Continuing Resolution for FY 1983 instructed the Department to complete our safeguards evaluation at the Barnwell Plant and to phase out activities by July 31, 1983. Accordingly, we have requested no funds for Barnwell in FY 1984. We remain hopeful, however, that some private sector initiative will be forthcoming whereby this valuable commercial facility will be allowed to operate.

ADVANCED NUCLEAR SYSTEMS

The final program I would like to mention is our development of Advanced Nuclear Systems in support of U.S. military and civilian space missions. Since 1961, the United States has launched 22 NASA and military space systems having all or part of their power requirements supplied by nuclear power sources. These include the missions by Pioneer, Viking, and Voyager. We are currently developing nuclear isotope power generators for the NASA Galileo spacecraft and the NASA/European Space Agency spacecraft, both planned for launch in 1986. Another major activity is the development of space nuclear power reactors in cooperation with NASA and DOD.

SUMMARY

Madam Chairman, in closing I would like to place the nuclear request for FY 1984 in perspective. It is important to remember that many of the programs are legislatively mandated and outside the scope of energy research and development. Examples are the Naval Reactor and Uranium Enrichment programs. When these are subtracted from the total request, there remains $837 million for energy supply R&D. Of that $837 million, $144 million is for noncommercial programs including waste management, remedial action responsibilities, and advanced nuclear systems activities in support of NASA and DOD missions. This leaves $693 million for fission energy R&D programs, i.e., breeder reactors, converter reactors, and the fuel cycle. These programs, which are ultimately intended for commercialization, are somewhat discretionary in character--that is, technologies that we are pursuing as a result of a conscious policy decision. The breakdown of funds is portrayed below:

	FY 1984 (in millions of $)
Total ASNE Budget	$1,450
Less:	
o Defense Activities (Naval Reactors)	-613
o Production Operations (Uranium Enrichment)	-2,240
o Revenue from Enrichment	+2,240
o Total Energy Supply R&D (Fission)	837
Less:	
o Waste Management	-16
o Remedial Actions	-94
o Advanced Nuclear Systems (Space)	-34
Programs Indended for Commercialization	693
o Breeder Reactors (CRBR)	-603 (270)
o Converter Reactors	-53
o Fuel Cycle	-37

I would like to point out that the $693 million requested for programs intended for commercialization represents only a 4 percent increase over the FY 1983 figure.

I recognize the difficult choices that Congress faces in its authorization and appropriation decisions. All programs have their attractive and supportable features and in more affluent times we could perhaps be less stringent in our funding selections. In view of the austere Federal budget, we have reexamined the nuclear program and have limited our efforts to activities that are sharply focused on a few critical objectives. We believe, Madam Chairman, that the request we are presenting for FY 1984 is as lean as we can make it and still do the job.

I will now describe the elements of the fission program in detail.

URANIUM ENRICHMENT

The goal of the Uranium Enrichment Program is to meet domestic and foreign utility and United States Government requirements for uranium enrichment services in the most economical, reliable, safe and environmentally acceptable manner possible.

The FY 1984 budget request for the Uranium Enrichment Program is $2,240,000,000 for authorization and appropriation, offset by $2,240,000,000 in projected revenues.

Projection of Uranium Enrichment Requirements

The Office of Uranium Enrichment and Assessment periodically estimates the domestic and non-U.S. nuclear electric generating capacity that will be served by the United States uranium enrichment complex.

Our mid-range estimate made last summer projected online worldwide nuclear power capacity to be served by United States uranium enrichment capacity to be 135 gigawatts in 1985, 178 gigawatts in 1990 and 204 gigawatts in 1995. Domestic nuclear power capacity included in these totals are 87 gigawatts in 1985, 119 gigawatts in 1990, and 123 gigawatts in 1995. The domestic forecast is based only on reactors currently operating or under construction. Our total forecast estimate is lower than projected in last year's testimony by 2 gigawatts in 1985, 4 gigawatts in 1990 and 22 gigawatts in 1995. The reduced estimate reflects additional delays and/or cancellations of nuclear power projects.

Long-Term Strategy

A long-term production strategy is necessary to permit orderly planning to meet projected uranium enrichment requirements. The strategy is chosen after considering economics, operational risks, and the flexibilities that are available to respond to higher or lower demand levels. In the short term, the strategy calls for lower operating levels of the gaseous diffusion complex and reduced inventories of enriched uranium. Even though the lower operating levels result in the purchase of power below existing contract levels, requiring the Department to pay capacity charges to its power suppliers for power not purchased, it remains the most economical way to operate. Recently completed technical studies indicate that significant risk is incurred from prolonged plant operation below design levels. Accordingly, in FY 1984, the complex will operate at 3,190 megawatts or 530 megawatts above the FY 1983 level.

The strategy also calls for continued design and construction of the Gas Centrifuge Enrichment Plant (GCEP) at Portsmouth, Ohio. The GCEP will initially provide an additional 2.2 million separative work units (SWU) of capacity by 1989 with completion of two process buildings. Completion of the full GCEP (eight process buildings) will be based on either demand for additional capacity or the need to reduce production costs. As less costly gas centrifuge capacity becomes available, the more costly gaseous diffusion plants will be reduced, beginning in the early 1990's. Continued research on advanced gas centrifuge and the atomic vapor laser isotope separation technology provides additional cost reduction opportunities.

United States Competitive Position

At present, the demand for uranium enrichment is relatively static, future sales prospects are limited and uncertain, and many enrichment customers have purchase commitments far in excess of their needs. Some utilities are offering to sell their excess enriched uranium in competition with the primary enrichment suppliers rather than incur substantial inventory costs. This has created a substantial secondary market and corresponding near-term sales perturbations. As a result, a highly competitive situation exists between the primary enrichment suppliers for a fixed market volume. Today, we are facing competitive pressures in the United States and in the international market from several existing suppliers with the following production capacities:

Foreign Enrichment Suppliers and Capacity Levels

Supplier	Capacity (millions of SWU/Year)
Eurodif	10.8 capacity; current production is lower
Urenco	1.0 currently; 2.0 by 1990
USSR	3 currently available for export

In addition to these suppliers, Brazil and South Africa are constructing enrichment plants of modest size, primarily to meet indigenous needs. Japan has announced plans to build a 1 to 2 million SWU plant by 1990 using centrifuge technology in order to realize the announced goal of meeting up to 33 percent of their own enrichment needs. This could limit U.S. sales potential in Japan after 1990. Also, Australia has initiated a feasibility study based on Urenco technology for an enrichment plant which would be available in the mid 1990's. The realization of these enrichment plans will continue to intensify competitive pressures upon the United States.

Delays in nuclear programs, inflationary costs, and an economic slowdown worldwide have all contributed to excess enrichment commitments, large available utility-owned inventories, and associated financial burdens for the nuclear community. This situation, in combination with the pressures of a growing secondary market and aggressive actions by our enrichment competitors, has adversely affected the U.S. share of the enrichment market. In contrast to its previous position of being the sole supplier of enrichment services in 1974, the U.S. share of the non-U.S. market has declined to about 30 percent today. A number of our foreign customers have switched from the U.S. to Eurodif, Urenco and the USSR, and some new business has gone to these suppliers. During 1982. for the first time, a domestic utility terminated its contract with the U.S. in favor of a foreign supplier. To date, the total value of sales the U.S. has lost to foreign suppliers is over $2.0 billion, with about $0.5 billion in lost sales occurring during the last year. In addition to these losses, a great number of direct U.S. sales are being replaced by secondary market transactions. Though sales replacement by excess enrichment commitments originally produced by DOE is understandable, secondary market transactions of non-U.S. enriched material for use as a replacement for U.S. sales is occurring more frequently. Three U.S. utilities and three foreign companies replaced approximately $30 million of potential U.S. sales during 1982 with heavily discounted excess foreign origin enrichment material. All of these sale losses are of great concern to us, and we must reverse this trend.

Price has become the most important sales consideration to enrichment customers. The price advantage of $30 to $50 per SWU enjoyed by the United States in 1981 no longer exists. More and more frequently, both the secondary market and our competitors have offered price guarantees at levels below the U.S. price. Their pricing strategy and the fluctuating exchange rates have further aggravated the U.S. sales position. These competitive forces and large secondary market quantities have created market instabilities and significant sales uncertainties for the U.S. enrichment business. The United States is faced with the need to compete in a highly unstable, low price enrichment market while at the same time financing the capital investments needed to implement advanced, low cost technologies that are vital if the United States is to maintain a market leadership position in the future.

We are taking a number of actions to enhance the market position of the U.S. uranium enrichment program. We are minimizing the current selling price by reducing costs and optimizing enrichment production activities. We are developing a new enrichment contract, the Facility Requirements (FR) contract, to provide needed stability between enrichment commitments and actual requirements by offering greater contract flexibility to customers. Finally, we are developing advanced, low cost technologies and deploying them on a schedule designed to make the most economically attractive enrichment services available to U.S. customers in the post 1990 time period. If successful, these steps will maintain and eventually expand the U.S. sales base, thereby enabling significant benefits in terms of domestic employment, balance of payments and a meaningful contribution to nuclear policies abroad.

Uranium Enrichment Activities

The budget for Uranium Enrichment Activities as shown in Chart 1 provides funding for three major program activities: (1) Gaseous Diffusion; (2) Gas Centrifuge, and; (3) Advanced Isotope Separation.

CHART 1

URANIUM ENRICHMENT PROGRAM

	Budget Authority (Dollars in Thousands) FY 1983	FY 1984
Uranium Enrichment Activities		
Gaseous Diffusion		
Cascade Power	884,000	$ 1,184,000
Other Operations and Support	316,353	297,300
Total Gaseous Diffusion	1,200,353	1,481,300
Gas Centrifuge		
GCEP	588,000	572,000
Other Operations and Support	94,500	109,800
Total Gas Centrifuge	682,500	681,800
Advanced Isotope Separation	50,633	73,000
Program Direction	3,650	3,900
Total Uranium Enrichment Activities	$ 1,937,136	$ 2,240,000
Uranium Resource Assessment	5,000	0
Subtotal	1,942,136	2,240,000
Uranium Enrichment Revenues	-1,968,319	-2,240,000
Total, Uranium Enrichment Program	$ -26,183*	$ 0

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* The net FY 1983 appropriation, after revenues, is $0. The number shown reflects comparability adjustments.

Gaseous Diffusion

The United States presently enriches uranium to the desired U-235 product assay in the gaseous diffusion plants located at Oak Ridge, Tennessee; Portsmouth, Ohio; and Paducah, Kentucky. In these plants, the United States enriches customer-provided natural uranium in the U-235 component for a fee which recovers the cost of providing the services.

In FY 1984, $1,481,300,000 is requested for operation of the gaseous diffusion complex. The three gaseous diffusion plants will operate at a power level of 3,190 megawatts in FY 1984 and produce about 12.1 million SWU. The FY 1984 operating level is consistent with our long-term enrichment strategy and represents an increase of 530 megawatts above the FY 1983 level of 2,660 megawatts. Recent technical studies indicate that prolonged operation below 3,190 megawatts would run a significant risk of extensive equipment failures. This could result in the loss of plant capacity and the release of radioactive material.

The 3,190 megawatt power level is substantially below the 5,781 megawatts we are contractually committed to purchase under existing contracts with the three power suppliers. Consequently, we are contractually required to pay about $243,000,000 in capacity charges in FY 1984 (Tennessee Valley Authority (TVA)--$226,000,000, and Ohio Valley Electric Corporation (OVEC)--$17,000,000) for power under contract that will not be purchased. If the Department purchased power at the contractually committed level of 5,781 megawatts, the FY 1984 power budget would be increased by $680,000,000 from $1,184,000,000 to $1,864,000,000.

We are continuing discussions with the power suppliers in an attempt to reduce the capacity charge payments for power not purchased. As in the past, the success of these negotiations depends on the ability of our power suppliers to transfer contract power not purchased by the Department to other customers. Relief from OVEC for FY 1984 is heavily contingent upon the level of economic activity in the Midwest. Relief from TVA is unlikely at this time because of the surplus generating capacity within TVA's own system, as well as within neighboring systems.

The total FY 1984 cascade power budget, including $226,000,000 in TVA capacity charges, is $1,184,000,000. This is an increase of $300,000,000 over the FY 1983 budget and is due to the purchase of the additional 530 megawatts, increases in the cost of power purchased and increased capacity charges for power not purchased.

Funding requested for diffusion operations, process and long-range technical support, supporting services, capital equipment and construction is $297,300,000. This is a net decrease of about $19,100,000 from the comparable FY 1983 budget. The major decreases are in the requirements for capital equipment and line item construction projects. The only budget increase is in the plant operations account primarily related to existing labor agreements. The requested funds are the minimum amounts needed to operate the plants; to replace equipment that has exceeded its useful life; to properly maintain the plants; and to comply with environmental and safety standards.

New construction projects for the gaseous diffusion program include: storage yards and cylinders for UF_6; general plant projects; utilities upgrading; intermediate gas removal; and power systems protection improvements.

Funding is also requested to continue projects authorized in previous fiscal years.

Gas Centrifuge

The FY 1984 budget request contains $572,000,000 for the construction of GCEP and $109,800,000 for other centrifuge activities.

The GCEP will provide an additional 2.2 million SWU per year of capacity by 1989. This GCEP capacity will be increased to 3.3 million SWU per year through upgrading with advanced gas centrifuge machines now being developed; even further advancement in centrifuge machines now appears achievable.

DOE continues to support the need for GCEP based on the results of the Department's thorough analyses of the alternatives available to the enrichment enterprise. These analyses carefully examine various production scenarios and evaluate the merits of each on the basis of cost, both to the Government and to the customer; impact on U.S. enrichment prices and our competitive position in the international market; energy efficiency; and technical achievability. Construction of GCEP will yield superior benefits both to the Government and its customers in terms of improved economics and production reliability. Even at reduced demand levels, the cost of production from GCEP in current year dollars will be significantly lower than production from the existing electricity intensive gaseous diffusion plants (GDPs). When escalation is factored in, the difference between GCEP and GDPs becomes very large.

The rapid deployment of enrichment technologies capable of reducing U.S. production costs is a necessary and prudent business decision. Our centrifuge technology is the most advanced proven enrichment technology in the world and offers the U.S. the opportunity to halt the erosion in our existing enrichment contract base and to regain its leadership and market share in the international nuclear community. The Advanced Gas Centrifuge and the Atomic Vapor Laser Isotope Separation technologies currently under development by the Department offer the promise of even lower future costs but must reach a more mature stage of development before they can be counted on for production planning.

We have emphasized to all existing and potential customers that appreciable cost reductions are expected in the U.S. enrichment program by virtue of U.S. leadership in and utilization of advanced enrichment technologies. Our customers universally accept the concept that future enrichment prices will be more favorable with the incorporation of the more economical, less energy intensive centrifuge technology being installed in GCEP.

Without GCEP, U.S. enrichment prices will be perceived by our customers as being significantly higher in the future. This fact has been emphasized by our competitors, Eurodif and Urenco. Our competitors stand to gain a considerable market advantage if the potential of GCEP is not realized in the U.S. Though a detailed estimate of potential sales losses is not possible, the continued strength and vitality of a U.S. Government enterprise which produces $2 to $3 billion in annual revenues, of which about one-third represents a positive contribution to the U.S. balance of payments position, is a worthwhile consideration. In this regard, the commitment to building GCEP is a major positive force.

GCEP is making excellent progress and is on schedule with the total estimated cost (adjusted for escalation) constant. Project momentum continues at a high rate as construction progresses. Process Buildings No. 1 and No. 2 are enclosed. In Process Building No. 1, the floor modules for the centrifuge machines and electrical, heating and ventilation systems are installed. Process piping is under contract and installation is proceeding. Site preparation and rough grading for all eight process buildings is complete. The Recycle/Assembly Building is enclosed and a portion of the building has been turned over to the operating contractor. The fire station, central receiving warehouse, mobile equipment garage, the administration building, electrical substations, and several support buildings are finished. Work on the central control room, the Feed and Withdrawal Building and utilities is underway. Through FY 1983, $2,173,520,000 has been authorized and $2,127,845,000 appropriated, with costs of $1,811,493,000 against a total estimated project cost of $7,450,000,000 in FY 1984 dollars. Design of the GCEP Project is over 89 percent complete with seven of the nine major architect engineers having finished their design efforts. Three centrifuge machine manufacturers have constructed and are operating manufacturing facilities in Ohio and Tennessee using corporate funds. All of the centrifuge manufacturers are now fabricating centrifuge machines on production tooling. Centrifuge machines are operating in the Life Test Facility and the Centrifuge Plant Demonstration Facility (CPDF). The CPDF is a full cascade which will be replicated many times in GCEP. Other manufacturing facilities for materials and components for the GCEP project are in place and in production.

In August of 1982, the CPDF became operational with industrially supplied centrifuges. Start-up, operation, and performance of the machines to date have exceeded all expectations in terms of machine reliability and capacity. The balance of plant equipment operation has been equally successful.

The FY 1984 request for other centrifuge operations and support includes funds for startup testing, procedures, and training to support operation of the GCEP. Also included are funds for the Advanced Gas Centrifuge development program, capital equipment and construction. The FY 1984 budget request for these activities is $109,800,000, an increase of $15,300,000 over FY 1983. Costs for GCEP startup activities are increasing by $21,700,000 over FY 1983 and developmental activities are decreasing by $6,400,000. The increase in startup activities reflects the testing of subsystems, preparation of operating and maintenance procedures, and personnel training. These activities are required in order to begin in-plant operational testing in mid-FY 1984, and to assure that Process Building No. 1 becomes partially operational by FY 1985.

The Advanced Gas Centrifuge (AGC) program consists of projects intended to provide production centrifuges with separative capacity substantially greater than the baseline (Set III) centrifuge. The Department is making good progress in demonstrating an advanced centrifuge, designated Set IV, which has separative capacity 1.5 times that of Set III. Efforts, to date, have verified that the speed and improved flow management techniques extrapolated from current technology have the potential of providing the anticipated performance gain. Full-scale centrifuge tests in this program during FY 1983 will establish which design features will optimize overall separative performance and achieve the desire 50 percent improvement.

In early FY 1983, we initiated research and development on a gas centrifuge concept with a potential separative capacity 2 to 3 times greater than the baseline centrifuge. Gas centrifuges developed within this effort are designated as Set V. A key feature of this program is the relatively high payoff it offers for a modest investment. We anticipate that the first phase, which covers two years, will encompass preliminary testing of full-scale machine rotors intended to verify that reliability testing and production design are warranted.

Advanced Isotope Separation

The objective of the Advanced Isotope Separation (AIS) program is to develop and implement a process that has the capability of producing enriched uranium at costs of less than $40 per SWU. In April 1982, the Atomic Vapor Laser Isotope Separation (AVLIS) process was chosen from three competing AIS technologies to proceed to the engineering development phase. The selection of AVLIS resulted from comprehensive technical evaluations of each technology. These evaluations included a risk assessment and an identification of the major technical uncertainties to be resolved prior to the initiation of the detailed design of large scale facilities. For AVLIS technology, the principal uncertainty involved the operability of the uranium collector subsystem. The FY 1983 AVLIS development effort will extensively examine this issue by operating existing testbeds. The goal of this effort is to develop the data base needed to design plant scale testbeds. Efforts will proceed to complete partially constructed testbeds, such as the Materials Handling Development Module (MHDM) which, when operated, will provide a validation of the FY 1983 data base at near plant scale geometries. Experiments will be conducted on enrichment demonstrations using the updated baseline feed and liquid collection of product and tails. Also we intend to complete a new point design using an updated feed concept.

The major AVLIS effort in FY 1984 will be to complete the detailed data package needed to proceed with engineering design and to initiate construction of experimental facilities capable of demonstrating the process at full scale. Technology development funds are also required to provide the information needed to initiate fabrication of the next generation of laser and separator subsystems. In addition, MHDM will become operational at the end of FY 1984. This facility will be used to demonstrate the thermal management of collector subsystems in MHDM. The FY 1984 funding requested for the AVLIS program is required to initiate evaluation of subsystem reliability, lifetime and engineering issues.

Uranium Resource Assessment

Although the data collection portion of the National Uranium Resource Evaluation (NURE) program was terminated in FY 1981, during FY 1982 a tremendous amount of the data were analyzed and made available to the public in reports, maps, and computer tapes. During FY 1983, essentially all of the remaining data gathered through the NURE program will be made available to the public. Thus, the major goals of this program have been achieved.

COMMERCIAL WASTE MANAGEMENT PROGRAM

The elements of the Commercial Waste Management Program include Remedial Action, the West Valley Demonstration Project, Commercial Low-Level Waste, and Waste Treatment. I will also discuss the Three Mile Island Program which is funded under the Converter Reactor Program but managed under the Commercial Waste Management Program.

Remedial Action Program

The objective of the Remedial Action program is to treat or stabilize radioactive wastes and perform required decontamination and decommissioning at contaminated DOE and legislatively dictated non-government facilities and sites. The major program areas are: (1) Formerly Utilized Sites Remedial Action Program (FUSRAP); (2) remedial action at Grand Junction, Colorado (P.L. 92-314, as amended); (3) Uranium Mill Tailings Remedial Action Program (UMTRAP) for inactive uranium mill tailings sites (P.L. 95-604); and (4) management of certain radioactively contaminated Department facilities declared surplus and resulting principally from civilian nuclear energy programs.

The FY 1984 budget request for the Program is $93.98 million as compared to a FY 1983 appropriation of $63.39 million. This also includes funds for the West Valley demonstration of the solidification of high-level radioactive wastes for final disposal (P.L. 96-368).

Formerly Utilized Sites

The Formerly Utilized Site Remedial Action Program (FUSRAP) provides for remedial actions at former nuclear processing facilities, most privately owned, which became radioactively contaminated from Manhattan Engineer District or Atomic Energy Commission activities and which have not been decontaminated sufficiently to meet current health effects guidelines for unrestricted use. Potential health risks limit the utilization of these properties, and property values may in some cases be reduced. To remedy the situation, the contamination will be either stabilized in-place, with restrictions placed on site use, or the contamination will be removed and disposed of at another location. Thirty-five sites have been identified as potentially requiring remedial action. DOE has remedial action authority at 14 sites. Only minimal activity, limited to some preliminary engineering and environmental studies required for planning, will be carried out for non-authorized sites. At sites where remedial action is undertaken, stabilization in place will be the preferred option. Where removal of the contamination is necessary, DOE sites will be utilized for the disposal of small quantities of contaminated material. In other cases, the affected State would be expected to select a new disposal site to be owned by either the Federal or State government. The Oak Ridge Operations Office has the lead field office role in implementing this program.

In FY 1983, the remedial actions begun in FY 1982 at Bayo Canyon and on the upper part of Acid Pueblo Canyon, Los Alamos, New Mexico, have been completed. Remedial action to clean up the main drainage ditches from the Niagara Falls Storage Site (NFSS) in New York will be completed.

Design engineering will be initiated for remedial action at the Shpack, Massachusetts landfill; at Middlesex, New Jersey municipal landfill; and at Linde Air Products in Tonawanda, New York. Preliminary engineering will be completed for the remedial action at the DuPont Deepwater, New Jersey plant.

In FY 1984, design engineering and NEPA documentation will be completed at Linde Air Products in Tonawanda, New York; DuPont in Deepwater, New Jersey; and Middlesex Landfill and Middlesex Sampling Plant Phase III in Middlesex, New Jersey.

Grand Junction

Under Title II of Public Law 92-314, Congress authorized financial assistance to the State of Colorado, to limit radiation exposure resulting from the use of uranium mill tailings for construction purposes in Grand Junction, Colorado. This State/Federal cooperative effort with the State of Colorado is administered by the Colorado Department of Health through the Grand Junction Area Office. The remedial action provides for removal of uranium mill tailings from the premises of about 626 structures where radon daughter exposures exceed the Surgeon General's guidelines. Public Law 95-236 extended the time for property owners to apply for inclusion in the program (which has now expired), and increased authorized program funding. Federal funds cover 75 percent of the program costs with the State providing the balance. FY 1985 is expected to be the last year Federal funds will be requested for the program. The Grand Junction Office administers this program. Through FY 1982, work had been undertaken at 472 structures including 400 residences, 12 schools, and 60 nonresidential structures. In FY 1983 the program will continue with radiological assessments and will initiate remedial actions at about 70 structures. In FY 1984, the program will complete remedial actions on 70 structures for a total of 612 structures out of a total of 626 to be completed.

Uranium Mill Tailings

The Uranium Mill Tailings Remedial Action (UMTRA) program is responsible for conducting remedial actions at 24 sites and an estimated 5,000-6,000 vicinity properties mandated by Public Law 95-604, "The Uranium Mill Tailings Radiation Control Act of 1978." Nine of the sites are designated as high priority, six as medium priority, and nine as low priority. The Act requires completion of the program within seven years of promulgation of standards by EPA, which were issued in December 1982. An evaluation is now ongoing to assess the feasibility and budget impact of the mandated 7-year schedule. After completion of the evaluation, an amendment to P.L. 95-604 may be offered to extend the period of DOE's authorization so the completion of the project can be accomplished in a more cost effective manner. Remedial actions will be conducted in accordance with cooperative agreements negotiated with the affected States and Indian tribes. Federal funds are to cover 90 percent of the remedial action costs (100 percent for those sites on Indian lands). The type of remedial action for the processing sites will be either to stabilize the mill tailings in-place, where feasible, or to remove the tailings to a new federally-owned disposal site. The program also includes the cleanup of properties in the vicinity of the processing sites which have become contaminated with radioactive material derived from the sites. It is estimated that from 5,000-6,000 vicinity properties--mainly in the Grand Junction area, but not authorized by the Grand Junction program--may be found eligible for cleanup. Engineering plans and environmental documents will be prepared for the cleanup and disposal operations at each site. The concurrences of the Nuclear Regulatory Commission (NRC) and the affected State (or Tribe) are required for each site remedial action plan.

Specific accomplishments planned for the balance of FY 1983 include the continuation of high priority remedial actions at vicinity properties near the Canonsburg, Salt Lake City, and Grand Junction sites and completion of detailed remedial action plans for four high priority sites (Canonsburg, Salt Lake City, Gunnison and Shiprock). In FY 1984, the program will complete NEPA work and initiate remedial action at these four high priority processing sites.

Surplus Facilities

This program provides for the safe management and disposition of the inventory of surplus Department-owned facilities that have been radioactively contaminated from civilian nuclear energy development programs. The decontaminated facilities and sites are returned to other productive use where appropriate. All defense-related DOE facilities are included in the Defense Nuclear Waste Management Budget. About 80 facilities are currently identified under this civilian activity. In addition, the program develops improved methods for decontamination and decommissioning which can be transferred to industry. A long range plan will be completed in FY 1984 to establish an overall schedule and priorities for sites currently in the surplus inventory. The Richland Operations Office has the lead field office role in implementing the program.

In FY 1983, the on-site activities at the Niagara Falls Storage Site will be accelerated with the goal of completing all interim work in early FY 1984. This will complete the impoundment of uranium residues and contaminated soils which are now in exposed or poor storage conditions in a new improved storage area, thereby assuring no further occurrence of off-site contamination and compliance with the State of New York requirements for radioactive effluent control. The engineering, design and planning phases of the Shippingport

Decommissioning Project will be completed in FY 1983. The decommissioning operations at the Mound Facility, Ohio in the Plutonium Processing and Research Buildings will be continued, and the removal of the Waste Transfer System will be started. This work is being carried out as part of a joint project with Defense Programs, with total project completion planned for FY 1988 at a total cost of about $64 million. The project will be 50 percent completed at the end of FY 1983.

In FY 1984, interim actions at the high priority Niagara Falls Storage Site will be completed and substantial progress will be made at other high priority sites. The work at the Mound Facility will reach 60 percent completion. The remedial action program will assume responsibility for the Shippingport Atomic Power Station from DOE-Naval Reactors in late 1984 after defueling and shipment of the fuel to Idaho is completed. During the third quarter of FY 1984 a decommissioning contractor will be brought on board to participate with DOE-NR contractors in plant shutdown and maintenance. Preparations for start of the Decommissioning Project will be completed in FY 1985. Current projections are that D&D of the Shippingport plant will take approximately 3 1/2 years and cost approximately $67M.

Field work at the Weldon Spring, Missouri Site will include start of the stabilization test of pit No. 4; a draft environmental impact statement will be completed for the residue storage pits and the quarry; design engineering will be started for long-term actions at this site.

Radiological Survey and Certification Activities

To promote further efficiency, the Radiological Survey and Certification Activity responsibilities relating to the Remedial Action Program were transferred from the Office of the Assistant Secretary for Environment, Safety, and Emergency Preparedness to my office in January 1983. These activities, funded in FY 1983 at $3.7 million, will be absorbed in the Remedial Action Projects.

West Valley Demonstration Project

The objective of the West Valley Project is to demonstrate solidification for disposal of high-level nuclear wastes under the provisions of Public Law 96-368, the "West Valley Demonstration Project Act". The project will carry out integrated production-scale development and demonstration of the treatment of the high-level liquid nuclear wastes at the Western New York Nuclear Center.

Major activities to be performed as part of the project include: (1) necessary decontamination required to prepare existing facilities and equipment at the Center to accommodate the solidification project; (2) removal of the wastes from the underground storage tanks; (3) development, design, construction and operation of systems and necessary supporting facilities for the solidification of the wastes; (4) acquisition of containers for the permanent disposal of the solidified waste; (5) temporary storage and transportation of the solidified waste to an appropriate Federal repository for permanent disposal; (6) decontamination and decommissioning (D&D) of the waste tanks, facilities, hardware, and material used in carrying out the project; and (7) disposal of low-level and transuranic wastes produced from project activities.

The CY 1982 program emphasized site takeover and initiation of project activities. This year the development of definitive solidification and decontainment plans for carrying out the project is receiving priority attention. With the planning, scoping, characterization, and baselining efforts completed in FY 1983, the FY 1984 program will implement these plans with major emphasis in waste solidification development and design, and decontamination and decommissioning.

Our recent major accomplishments in CY 1982 included:

- Site takeover; issued final Environmental Impact Statement, and Record of Decision.
- Made first manned entry into hot cell.
- Inspected and sampled waste storage tanks.

The FY 1983 program includes the following critical activities:

- Complete waste process and form selection.
- Complete solidification conceptual design.
- Complete decontamination of crane room and work plans and procedures for next four hot cells.
- Commence construction of vitrification equipment component test stand.

In FY 1984 we plan to accomplish the following:

- Complete preliminary (Title I) design of high-level waste solidification equipment and facilities.
- Complete procurement of equipment items for waste solidification component test stand.
- Complete decontamination of four hot cells and work plans and procedures for five more hot cells.
- Initiate procurement of LLW/TRU sorting facility and LLW volume reduction equipment.

Low-Level Waste

Public Law 96-573, the Low-Level Radioactive Waste Policy Act, assigned States the responsibility for assuring disposal capacity for commercial low-level radioactive waste (LLW) generated within their borders. The formation of regional compacts to satisfy this responsibility was encouraged by the law. The goal of the Department's LLW program is to assist states in the development of an effective national LLW management system by 1986 and to evaluate this system in terms of operational efficiency by 1988.

During FY 1983, the Program will complete the development of the regional LLW data base, and continue State/regional technical and financial assistance in support of P.L. 96-573.

The LLW program in FY 1984 will primarily provide technical and financial assistance to States and regions to support selection and operation of new LLW disposal facilities by 1986 (primarily through regional compacts).

Waste Treatment

The objective of this program is to develop and demonstrate technologies for the treatment and immobilization of nuclear fuel cycle radioactive wastes in forms acceptable for transportation, storage and ultimate disposal. Specifically, high-level waste, transuranic waste, and sodium contaminated wastes are addressed. Over the years, methods for treating high-level and transuranic wastes have been developed. This program is now focused on determining the long-term reliability and maintainability of improved prototypical waste treatment systems, on testing and selecting acceptable waste forms for storage or permanent disposal in licensed facilities, and on demonstrating the adequacy of these technologies through their application to specific Departmental waste treatment efforts such as those at West Valley and Three Mile Island (TMI). Activities in this program are coordinated with other Departmental efforts related to fuel reprocessing, generation of special wastes, transportation, and terminal isolation of Department and commercial wastes.

In FY 1983, the performance requirements and specifications for high-level (main focus) and transuranic waste forms and their containers will be developed. The adequacy of a glass waste form to meet these performance requirements will be examined. A reference waste form for commercial high-level wastes will be selected. In the waste immobilization area, emphasis will be on the latest technology for waste vitrification, the liquid fed ceramic melter. Improvements will be made in performance of the melter feed, off-gas and waste glass canister treatment systems. Preparation for development and evaluation of a waste form alternative to glass will also be undertaken.

In FY 1984, waste solidification activities will focus on vitrification process controls and quality verification methods for demonstrating that the glass waste products meet the required specifications developed in FY 1983. Specifications for transuranic wastes will be completed in FY 1984, and development of transuranic waste treatment processes will continue in preparation for future demonstration of these techniques on actual wastes. The sodium treatment facility will be converted to handle radioactive materials and will process contaminated sodium from the Experimental Breeder Reactor-II (EBR-II) operations utilizing the system demonstrated in FY 1983. Criteria and guidance for shallow land burial of sodium contaminated wastes will be tested and completed.

Three Mile Island Program

The Three Mile Island (TMI) program is funded under the Converter Reactors program but is managed and will be discussed under the Commercial Waste Management program. The objectives of the TMI program are (1) to acquire information and conduct R&D that will substantially enhance nuclear powerplant safety, reliability, and operation, and (2) to improve the technology and procedures for safely disposing of abnormal nuclear wastes resulting from an accident.

In consonance with the Administration's policy of private sector responsibility for commercial nuclear power activities, the Department's TMI program is limited to research and development that will be of overall value to the development and safety of nuclear power and waste management. Responsibility for the costs of TMI cleanup remains with General Public Utilities (GPU), the owner of the facility.

The TMI activities are being implemented in accordance with a memorandum of understanding by DOE, NRC, the Electric Power Research Institute (EPRI), and GPU. The efforts of GPU are aimed at plant cleanup and recovery. The Department has developed a program work scope that enables obtaining important R&D information that would not otherwise be available from the TMI-2 cleanup effort. The DOE program is being conducted in a manner that avoids delaying the GPU cleanup schedule.

In accordance with a Memoranum of Understanding between the DOE and the Nuclear Regulatory Commission, the Department will acquire unique radioactive waste, including the damaged core, from TMI for research and development and for disposal.

Two subprograms compose the TMI program: the TMI Data Acquisition Program and the TMI Waste Immobilization and Reactor Evaluation Program. The FY 84 budget request for this program is $37 million as compared to $29 million in FY 83.

TMI Data Acquisition Program

The objective of this subprogram is to obtain R&D data of generic value to the safety of light water reactors.

The DOE and EPRI are sharing responsibility and costs for portions of this R&D program. Specifically, the Department is funding data gathering, research and development, and information transfer in the following major areas: instrumentation and electrical equipment survivability, behavior of radioactive products, data system and specimen achieving, and offsite fuel debris examination. EPRI has responsibility for mechanical and structural component reliability, pressure boundary recharacterization, and decontamination and dose reduction associated with the primary coolant system.

During FY 1983, the analysis of the hydrogen burn event in the TMI-2 containment will be completed and the results provided to NRC and industry for use in calibrating their analytical techniques. Technology transfer activities in the instrumentation programs will be emphasized. Techniques to requalify electrical cables in-situ will be developed.

In FY 1984, DOE plans to conduct the in-situ and offsite examination of selected instrumentation and electrical components to ascertain their condition, cause of failure, and features which affect equipment survivability. Data obtained will be used to upgrade standards and guides, resulting in improved equipment for surveillance of nuclear plants. Efforts will continue on analyzing samples to identify how various radioactive isotopes, released within the containment building during the accident, were transported and deposited. These data will be valuable in assessing the existing models for fission product release which are used in nuclear powerplant licensing. Preparation for the offsite examination of fuel debris will be continued but actual examination will not begin until after defueling in 1984 and 1985. The computer data bank system will continue to collect, store and transfer to NRC and industry the data and documentation generated by the Department's program.

TMI Waste Immobilization and Reactor Evaluation

The objectives of this subprogram are: (1) to conduct research and development on immobilization of abnormal reactor waste products, and (2) to examine the TMI-2 reactor and core components in-situ and to support development activities associated with the reactor defueling. The data acquired will provide an improved basis for evaluation of licensing criteria and requirements, analysis of causes and consequences of accidents, and improvement of reliability of the design and operation of LWR's. This program element was initiated in FY 1982.

The waste management and immobilization activities are initially being focused on an effort to demonstrate the feasibility of vitrifying zeolite ion exchange materials. The program will have demonstrated this feasibility in FY 1983.

Beginning in FY 1983 and continuing in FY 1984, this subprogram will focus on other techniques for the treatment of abnormal wastes produced at TMI, including alternative immobilization concepts for inorganic ion exchange zeolites and organic resins, confidence testing and long term sample observation to provide a more extensive data base. Some of the areas which will be addressed include demonstration of liner disposal in a high integrity container, resin solidification and lysimeter testing. The knowledge gained will contribute substantially to the technology for processing and disposing of unique waste forms resulting from abnormal reactor operations and accidents.

The reactor evaluation activities include examination, removal, and disposition of the reactor core and internals. The special systems, equipment, facilities, and processes needed to accomplish the defueling operation, including examinations, tests, and evaluations of the fuel, will be developed.

To date, over 170 manned entries have been made into the reactor to determine both the extent of damage and the resulting program requirements. Principal efforts will be directed to the goal of removing the reactor head late in FY 1983. In parallel, the development and engineering of systems, equipment and procedures for reactor plenum removal and storage and for reactor defueling and fuel transfer will be initiated. In FY 1984, plenum removal will be accomplished and core disassembly activities will begin. Work will be directed toward preparing for a thorough examination of the reactor internals and core and performance of defueling activities in a radiation environment as low as practicable. Substantial beneficial data on the condition of the reactor core and other internal components will be obtained. In addition, preparations will be made for extensive off-stie examinations of the fuel, debris and reactor internal components to characterize the accident effects.

This program will provide the data required for evaluating present licensing criteria and requirements; developing future licensing criteria; assessing and developing computer models used to analyze the course and consequences of severe accidents; developing means to mitigate the effects of such accidents; and evaluating improvements to reactor design, operation, and maintenance.

BREEDER REACTOR SYSTEMS

The objective of the Breeder Reactor Systems program is to complete the research and development of the breeder technology to the stage appropriate for transfer to industry. Ultimately the private sector--nuclear reactor vendors, other suppliers, architect/engineers, and utilities--has responsibility for plant investment and commercialization decisions. The major thrust of programmatic activity is directed toward the Liquid Metal Fast Breeder Reactor (LMFBR). A smaller, complementary effort is directed at the Water Cooled Breeder. The breeder reactor systems funding request for FY 1984 is $602.5 million as compared to $549.9 in FY 1983. Distribution of the funds is as follows:

	FY 1983	FY 1984
	(in thousands)	
Breeder Reactor Systems		
Liquid Metal Fast Breeder Reactor	$496,829	$556,825
Water Cooled Breeder	44,984	35,500
Program Direction	8,061	10,200
Total	$549,874	$602,525

Liquid Metal Fast Breeder Reactor Program

The LMFBR program consists of a streamlined research and development effort aimed at private sector industrial deployment. The program consists of three broad elements: (1) construction and operation of the Clinch River Breeder Reactor Plant (CRBRP), and cooperative planning for a follow-on, large-size prototype breeder to be financed, constructed, and operated primarily by the private sector; (2) a supporting base technology program, including test facility construction and operation and technology research and development efforts in reactor fuels, components, physics, and safety; and (3) a supporting fuel cycle program (funded separately).

The first two elements are closely integrated and are directed at breeder powerplant development, while the fuel cycle effort provides the basis for integrating breeder reactors into an existing and expanded nuclear energy economy. The focus of the breeder program is the development of an economically competitive breeder that is inherently safe.

Clinch River Breeder Reactor Plant Project

The overall objective of the CRBRP project is to design, construct, and test the nation's first intermediate scale (375 megawatt electric) LMFBR powerplant and operate the plant as part of a utility system. The project is a joint undertaking of the U.S. Government and 753 electric systems from the public, private, municipal, and cooperative sectors of the utility industry. Its size represents a technically significant yet prudent scaleup in plant technology. The construction site for the CRBRP is located in Oak Ridge, Tennessee, where it will operate as part of the TVA electricity supply network. In addition to fulfilling its principal objective of advancing breeder technology, the plant will produce electrical power sufficient to meet the needs of 200,000 people.

The importance of this project is widely recognized. President Reagan in his October 8, 1981, policy statement on nuclear power stated that completion of the Clinch River plant "is essential to ensure our preparedness for long-term nuclear power needs." The CRBRP will provide valuable technical information from the results of the plant design; fabrication of plant components; and plant safety, licensing, construction, and operating experience.

The CRBRP project is presently authorized under Public Law 91-273, as amended. Under the law, Congress authorized the Agency to enter into a definitive cooperative arrangement for an LMFBR plant. The cooperative arrangement, called the quadripartite contract, between the Agency, Project Management Corporation (PMC), Tennessee Valley Authority (TVA), and Commonwealth Edison (CE) has been in effect since 1973.

In the last Congress, CRBRP was subject to a wide ranging debate. Funding for the CRBRP was provided for FY 1983 with a requirement for a vigorous exploration of possible methods for reducing Federal budget requirements. In response, the utility industry has established a task force of senior financial executives to prepare proposals for greater industry cost-sharing in the project. A Department of Energy recommendation and the task force report will be forwarded to the Congress by March 15, 1983.

At the same time, following authorization from NRC, site preparation has been proceeding for several months, and plant design, hardware procurement, and licensing activities are now well advanced. By the end of FY 1983, about $1,600,000,000 will have been spent on these activities ($1,450,000,000 in Government funds and $150,000,000 in utility and other contributions). The net remaining cost to the Government to complete the project is approximately $2,000,000,000. This amount would be reduced by increased utility industry financing.

The Clinch River Plant design has been updated continuously and reflects current regulatory requirements and new breeder developments in the United States and abroad; it is at the forefront of world breeder technology.

Important actions and accomplishments realized to date include: (1) receipt of NRC authorization pursuant to 10 CFR 50.12 to conduct site preparation activities; (2) completion of site suitability and environmental hearings; and (3) issuance by NRC of the Site Suitability Report and the Supplement to the CRBRP Final Environmental Statement--both of these documents contain findings favorable to the project. Continued progress in the licensing area is expected to lead to NRC authorization in FY 1983 to begin safety related construction activities in early FY 1984.

Other aspects of the project are well advanced. By the end of FY 1983, design of the plant will be near completion; about $750,000,000 of the hardware required for the plant will be on order or delivered; hardware deliveries alone will be valued at approximately $406,000,000. Consistent with NRC's authorization, site clearing and excavation will continue during FY 1983.

Planned activities during FY 1984 include further licensing activities, completion of site preparation, and initiation of construction of permanent plant structures. Continued progress will be made in the fabrication of hardware. Component completions planned for FY 1984 include the polar crane, the service building bridge crane, the upper internals structure, the radwaste solidification system and the air blast heat exchanger. In addition, substantial progress will be made on fabrication of other plant hardware, including the plant steam generators and pumps.

Our confidence in the ability to complete the plant in a cost effective and timely manner is based on the advanced state of its design, the advanced completion of hardware, the testing of prototype equipment, and the licensing and research and development being done.

Large Scale Prototype Breeder

The technical and economic uncertainties of proceeding to a commercial-size demonstration of a large breeder reactor are understandably unreasonable for the private sector to bear alone at this time. The intermediate-size CRBRP and the breeder base technology program are directed at reducing these technical and engineering uncertainties to acceptable levels whereby the private sector could take the lead for the next major plant project. The design, construction, and operation of a large developmental breeder plant at near-commercial size will provide further confirmation that these risks are at an acceptable level to private industry.

The U.S. Government and private industry are cooperating to establish institutional and financial arrangements, and to develop implementation plans for proceeding with the design, construction, and operation of a near-commercial-size breeder. Ultimately the effort is expected to include foreign government participation. Private industry is expected to take the lead and assume principal responsibility for planning and total responsibility for financing and constructing the large scale prototype breeder.

An agreement between the Department of Energy and the Electric Power Research Institute (EPRI) to cooperate on the large scale prototype breeder effort was executed in FY 1982. EPRI has established a Consolidated Management Office (CoMO) to execute its responsibilities under the terms of the DOE-EPRI agreement. CoMO staff include representatives of the utility industry, reactor manufacturers and architect engineers. The private sector is contributing $10 million to this effort over the next two years; DOE has budgeted $15 million for FY 1983 and is requesting $15 million in FY 1984.

FY 1983 CoMO efforts are directed at: 1) establishing specifications for the large breeder that reflect requirements of the utility industry and design commonality, where possible, with foreign participants; 2) incorporating appropriate design changes into the previously established large plant advanced conceptual design to provide inherent safety, competitive economics, and low technical risks; 3) advancement of design with emphasis on capital cost reduction; 4) establishment of plant schedule and cost estimates; 5) continued evaluation of potential sites; and 6) initiation of environmental and safety documentation.

CoMO efforts during FY 1984 will be directed at finalizing all aspects of planning for the large scale prototype breeder. This includes definition of plant requirements and criteria; a schedule; a cost estimate; an evaluation of sites; research and development requirements; and financial, institutional and management arrangements. A safety analysis report, an environmental report, and a financial plan will also be prepared.

Liquid Metal Fast Breeder Reactor Base Technology Program

This program provides the technology base to enable the plant projects to proceed in a cost-effective manner, so the private sector can proceed with industrialization and deployment of the LMFBR.

The mission of the LMFBR base program is to develop the requisite technology to the point where the private sector is able to support construction and operation of safe, reliable liquid metal fast breeder reactor plants for supplying electricity to the grid.

The past year was a significant one for the base technology program in that many previous promises were realized. For example, the Fast Flux Test Facility (FFTF) ran for over 50 days of sustained full power operation, a U.S. LMBFR record. In addition, the FFTF was selected as one of 10 outstanding achievements of 1982 by the National Society of Professional Engineers. Another significant event was the start of performance testing of the Clinch River steam generator and main cooling pump at the Energy Technology Engineering Center (ETEC). Planned activities during FY 1983 include completion of the fuel storage and maintenance facilities at the FFTF site, initiation of water testing for the large developmental pump, and shipment of the Babcock and Wilcox helical coil steam generator for testing. Final concrete pour for the Fuels and Materials Examination Facility will be completed in FY 1983.

A more complete description of activities are highlighted in the section that follows.

Engineering Systems and Components

The Engineering Systems and Components program objective is to advance the state of knowledge and component technology development to the point where future economic and technical risks of designing, building, and operating safe, reliable, and economic breeder reactor components are acceptable and can be undertaken by the private sector.

The base program is not responsible for building large components for a project; rather, R&D is performed on new concepts that will form the technology base for the ultimate industrial decision. The program is carried out through generation of new concepts, identification and resolution of critical technical problems inherent in such designs, computer code prediction of design performance, conduct of R&D to verify behavior predictions of chosen materials in new configurations and environments, and testing of integrated concepts as models or test units to verify successful performance prediction and problem resolution.

R&D underway to support component technology development includes flow induced vibration analysis (including small scale Intermediate Heat Exchanger [IHX] flow tests, flow distribution testing and analysis, mixing and stratification testing and analysis), subcomponent development and testing, fabrication process development, inspection development, maintenance equipment, and procedure development. The Agency utilizes its unique facilities, including the Energy Technology Engineering Center (ETEC), for much of this testing, as well as industrial facilities where they exist.

To reduce technological risks and economic costs associated with components to a level acceptable for further private sector development, significant advances must be made in component reliability. There are two reasons for this. First, experience with breeder reactor powerplants in this country and abroad (Fermi, PFR, Phenix, BN-350, BN-600) has shown that plant component failures have been a major source of plant unavailability. Reliability problems are a cause not only of major economic impact, but also of potential impact on overall plant safety. The first aspect of assuring plant safety is to demonstrate reactor system reliability in preventing the occurrence of accident events that could ultimately lead to plant safety problems. The component technology development activities, including steam generator component and leak protection system development, support this reliability requirement.

Second, new component concepts must be developed since the requirements for commercial plants are different and, in some cases, much more stringent than those for demonstration plants, like CRBRP. For example, since the primary pump suction requirements for future plants are much higher than for CRBRP, development of a new concept such as a two-stage pump is required. This is an area of major program focus.

Likewise, components having major cost reduction potential must be developed and proof tested. Program focus centers on primary system inducer pumps, intermediate system pumps, instrumentation development, plus critical reviews of requirements imposed on components.

FY 1983 major accomplishments include:

- Complete the large leak sodium-water reaction testing series. The testing, which uses a prototypical CRBRP steam generator tube bundle, verifies analytical predictions of sodium-water reaction effects and confirms the need for reliable fast response leak protection systems.

- Complete water testing of a 1/3 scale model pump that duplicates the hydraulic characteristics of the 85,000 GPM intermediate system, sodium pump test article. Successful completion demonstrates acceptable hydraulic performance characteristics.

- Complete assembly of the helical tube bundle of the single wall tube, 70 MWt model steam generator. This accomplishment is a major milestone in demonstrating that a successful helical coil steam generator can be designed, fabricated, and operated for large LMFBR plant conditions.

- Complete the seven-tube model steam generator test program in October 1982. This test program, conducted at Westinghouse expense, demonstrates acceptable thermal and hydraulic characteristics for the Westinghouse double-wall tube steam generator design.

- Start assembly of the 85,000 GPM, two stage, primary system sodium pump test article and water test in preparation for sodium testing beginning in 1985 at the Energy Technology Engineering Center. This accomplishment is a major milestone in demonstrating that a successful primary system pump can be designed, fabricated, and operated for large LMFBR plants.

The FY 1984 activities include critical research and development efforts on steam generators and pumps. Planned accomplishments for FY 1984 are:

- Continue preparations for sodium testing of the helical coil model steam generator and the primary system two stage pump test article.

- Initiate tube installation in the 70 MWt double-wall tube steam generator.

- Complete design and continue fabrication of the intermediate system pump sodium test article.

- Continue primary system inducer pump design to secure weight and cost savings.

- Complete demonstration of leak protection system on prototype steam generator.

Fuels and Core Design

The goals and objectives of the fuels program are: to prove a breeder fuel; to extend core life to burnup levels needed for commercial performance; to develop and prove the companion fuel blanket and absorber core component systems, to demonstrate LMFBR core systems that are licensable, to support CRBRP core requirements to extend core components' lifetime (to 3 years); to develop, establish and demonstrate an integrated fuel supply for FFTF and CRBRP; and to transfer developed technology to industry.

FY 1983 accomplishments include:

- Successfully test FFTF mixed oxide fuel against all of its initial performance goals. The strategy is to prove that we have a sound LMFBR fuel and a sound blanket and absorber core system and to extend core life to burnup levels needed for economic performance.

- Develop a system for detecting, locating, and identifying cladding leaks in fuel pins. System identified an experimental fuel pin as a "leaker" when the cover gas contained less than 2 parts per billion of fission and tag gases.

- Improve lifetime of absorber assemblies (from one to two years). Additional data have shown that three-year lifetimes are attainable, consistent with the lifetime goal for economically competitive cores.

- Evaluate results from an FFTF test assembly, specifically designed to determine the fuel pin power (Kw/ft) required to initiate melting in fresh fuel. Resulting data improve the accuracy of performance prediction codes.

- Successfully compare predicted and measured FFTF core temperatures.

- Culminate technical exchange agreements with foreign countries. About $17 million of foreign funds will be provided for cooperative programs on fuel performance.

- Insert the Materials Open Test Assembly (MOTA) in the FFTF. The MOTA can monitor, maintain, and vary specimen temperatures.

- Complete conceptual design and continued development of the Secure Automated Fuel Fabrication Line (SAF) to produce LMFBR fuel using automated and remotely operated equipment and processes. This hands-off fabrication system eliminates personnel access to materials, essentially eliminates personnel exposure, and incorporates quality control, safeguards and security provisions to assure high product quality and protection against diversion.

Planned FY 1984 accomplishments include:

- Qualify, confirm performance, and establish lifetime limits of the FFTF fuel and absorber systems.

- Conduct fuel, blanket, absorber, and cladding/duct alloy program to assure safe, reliable, and predictable long-life performance.

- Continue efforts to support CRBRP fuel, absorber, blanket, and design code requirements.

- Complete SAF line final design.

- Continue optimizing current needs for destructive and nondestructive examination of fuels, blankets, absorbers, and materials to insure cost effective operation of national hot-cell facilities.

- Continue Run-Beyond-Cladding Breach (RBCB) and Transient Overpower Tests on oxide fuels as part of joint U.S./Japanese program in EBR-II.

Materials and Structures

As a vital part of the LMFBR program, efforts within the Materials and Structures area are directed at the resolution of problems typically experienced during plant design, construction, licensing, and operation; performing research and development as identified by plant projects; and establishing and documenting the technology base required for LMFBR industrialization.

The Materials and Structures activity addresses programmatic needs by:

- Providing technology to assure that LMFBR components and systems are free from structural failures during their design lifetime.

- Developing materials, design methods and criteria, materials property data, and procedures that will assure economic and safe components and systems while providing designers with sufficient flexibility in component and systems design to facilitate optimization.

The overall strategy includes (1) developing and providing timely design tools and guidance to design teams, (2) performing necessary R&D in support of the ultimate design choices, (3) maximizing the use of information derived from previous generic and specific (e.g., FFTF, CRBRP) research and development, and (4) maximizing the use of information derived from foreign exchange agreements. While early program emphasis was on structural integrity to assure reliability and safety, increasing emphasis is being given to economic considerations and the ability of the private sector to proceed with the next LMFBR plant.

FY 1983 accomplishments include:

- Complete generation of mechanical properties data and issued equations that will allow more accurate structural analysis for advanced steam generators and design support for CRBRP steam generators.
- Complete measurement of fracture mechanics properties that will be utilized in the design of CRBRP reactor vessel internal support structure, thereby allowing the design to continue on schedule with confidence.
- Complete determination of physical properties for stainless steel castings that will aid in lowering costs of components.
- Complete a series of important steps with the American Society of Mechanical Engineers to allow the use of 9 Cr-1 Mo steel that will prepare the breeder industry for major advancements in the utilization of this high strength, low cost material.
- Complete seismic testing of a small piping model, thereby verifying the conservatism of current design methods leading to reduced hardware costs, and providing designers and NRC with more accurate data and techniques for seismic design and evaluation.

Planned accomplishments in FY 1984 include:

- Complete development of methods for inservice inspection of double-wall tube steam generators.
- Complete development of seismic analysis methods for LMFBR core assemblies.
- Publish design methodology for elevated-temperature piping expansion joints.
- Develop design methods and criteria for elevated-temperature welds.

Physics

The purpose of the physics program is to prove and reduce to practice LMFBR data bases and analytical design capabilities needed for FFTF operation, CRBRP licensing, plant startup and efficient performance, and confident design of a commercial plant. Key elements are acquisition, testing and implementation of detailed nuclear data and analytical design capabilities, measurements and analyses of physics parameters in critical assemblies, and analyses of advanced core and shield design options. Priority efforts provide direct support of specific CRBRP licensing matters and studies of FFTF operating data, and contribute capabilities needed by industry for predicting the design and safety of future LMFBR plants.

FY 1983 accomplishments include:

- Conduct experiments in Zero Power Plutonium Reactor, the largest fast reactor critical facility in the world, to measure reactivity worth of sodium voids. Tests will aid the resolution of this problem in CRBRP before the Nuclear Regulatory Commission.
- Conduct measurements in Zero Power Plutonium Reactor that identify the reason for a longstanding difference between measured and calculated values of reactivity changes caused by use of difference materials in breeder reactor designs. This will improve accuracy in calculations and result in lower cost cores.
- Provide industrial designers with an advanced design code that will produce major improvements in accuracy and resultant reductions in the cost of design calculations.

Major program accomplishments expected in FY 1984 are:

- Perform engineering benchmark criticals for 700 MWe-scale heterogeneous cores in Zero Power Plutonium Reactor. These will address aspects of design for which no confirmatory data exist.
- Perform analyses of the most crucial shielding issues for advanced LMFBRs.
- Validate advanced transport and three dimensional design methods and data files for accurate and economical analyses of large critical experiments, reactor operating data, and industrial design of advanced LMFBRs.
- Perform measurements of nuclear data required for later completion of Evaluated Nuclear Data File-VI.
- Perform analyses of early Fast Flux Test Facility operations and fuel burnup contributing to evaluation of neutronic methods and data bases for CRBRP and future plants.

Safety

The Safety program is directed to the public safety considerations associated with LMFBR's. The mission of the program is to: provide an adequate data base for licensability and assessment of risk to the public, and influence safety design features of LMFBR's. The efforts lie in two main areas: 1) prevention of accidents and 2) mitigation of accident consequences.

The safety program supports the licensability and industrialization of the LMFBR by demonstrating the public safety of large breeder reactors.

It influences LMFBR design by identifying and exploiting inherent plant characteristics to enhance safety, reduce complexity, and reduce capital cost. Action will be taken in parallel with these activities to develop plant safety design criteria and a licensing approach that will reflect the renewed emphasis on inherency, improved safety, and reduced cost.

The program addresses important technical issues in both accident prevention and mitigation of accident consequences as follows:

1. Reliability of plant systems and safety features--through accumulation and analysis of performance data from operating plants.
2. Safety margins under degraded plant conditions--through verification of sodium natural circulation cooling under extreme transients.
3. Accommodation of core disruptive accidents--through demonstration of adequate containment of energetic accidents and heat-producing accident debris.
4. Plant siting and accident health effects--through demonstration of limited fuel aerosol releases to the environment.

FY 1983 accomplishments include:

- Install a newly developed man-machine interaction system in FFTF. This system will minimize operator workload and aid in scheduling maintenance and repairs for more than 50,000 operating plant components.
- Complete a series of eight in-reactor safety experiments in the Transient Reactor Test Facility. This was the first set of experiments conducted under the US/UK agreement to provide useful licensing data.
- Complete a series of out-of-pile experiments that demonstrated inherent capability of molten fuel to disperse away from the core during serious accidents, thereby shutting down the reactor.
- Complete a series of sodium concrete reaction experiments that allow DOE and NRC to resolve a controversial matter, resulting in elimination of a CRBRP licensing issue.

Major program accomplishments expected in FY 1984 are:

- Complete three safety transient tests of breeder reactor fuel in TREAT.
- Complete the first major decay heat removal test series in the Thermal-Hydraulic Out-of-Reactor Safety (THORS) Facility.
- Complete Self-Actuated Shutdown System (SASS) component development and provide large plant project with recommendations on preferred configuration and integrated system testing.

- Complete a water experiment that validates multidimensional computer codes for in-vessel decay heat removal in large plant designs.

- Complete severe protected sodium natural circulation tests in EBR-II.

Test Facilities

The major objective of the test facilities effort is to provide an experience base for safety, components, and system operation. This experience provides a proven baseline for scaling up systems and components and provides a library of developed and verified sound operating and maintenance procedures to plant projects and the base technology program. The test facilities effort operates and maintains facilities and multiprogram sites at Hanford Engineering Development Laboratory, Energy Technology Engineering Center, and Argonne National Laboratory to meet LMFBR program test requirements and schedules established by the breeder technology research and development program.

FY 1983 accomplishments include:

- Complete initial performance tests on the CRBRP plant prototype steam generator in the 70 megawatt Sodium Components Test Installation at Energy Technology Engineering Center. Results will be factored into fabrication release for CRBRP plant units. This first major use of Sodium Components Test Installation since upgrade from 35 to 70 megawatts thermal demonstrates operability of the world's largest LMFBR steam generator test facility.

- Complete planned performance test program on the CRBRP prototype primary sodium pump in the Sodium Pump Test Facility at Energy Technology Engineering Center. Confirm basic pump design and identify changes desirable for CRBRP plant units, and demonstrate operability of the world's largest LMFBR Sodium Pump Test Facility.

- Complete comprehensive series of large leak sodium-water reaction tests on full diameter model of CRBRP steam generator in the Large Leak Test Rig at Energy Technology Engineering Center. Provide confirmation to predict and accommodate large leaks in the LMFBR steam generator systems. Confirm need for prompt leak detection and response techniques to avoid economic penalty.

- Complete first full cycle of the Fast Flux Test Facility operations. This operation established record for longest period of continuous full power operation (53 days) of any United States liquid metal fast breeder reactor to date. Initiate experimental irradiation testing to confirm breeder reactor reference and advanced fuel systems.

- Complete concrete emplacement in the Fuels and Materials Examination Facility at Hanford.

- At the Hot Fuel Examination Facility, continue handling and examinations of Fast Flux Test Facility, the Transient Reactor Test Facility including the United States/United Kingdom joint tests, and the Experimental Breeder Reactor II test fuel. Examination of first FFTF driver fuel experimental assembly demonstrates facility capability to support FFTF operations and experimental testing program.

- Achieve cumulative 19 year electricity production of over 2 billion kilowatt hours at EBR-II, and cumulative 19 year irradiation capability of over 200,000 megawatt-days thermal.

In FY 1984, the actions initiated in prior years to consolidate testing and demonstration activities will continue. Existing facilities will be used where they are adequate for R&D program needs and surplus facilities will be phased out. Initiatives will be pursued to further reduce operating costs of the various test facilities.

Water Cooled Breeder Program

The Water Cooled Breeder program's mission is to develop technology for significantly improving the efficiency of nuclear fuel resource utilization by water cooled nuclear reactors used for electrical power generation. The concept being evaluated is a self-sustaining breeder reactor, cooled and moderated with ordinary (light) water and fueled with uranium-233 and thorium.

Successful confirmation of breeding in the Shippingport light water breeder core will provide the basic technology that would make available for power production about 50 percent of the energy in the nation's thorium reserves, a source of energy many times greater than the known fossil fuel reserves. This concept is the only known approach using the proven technology of the light water reactor system for increasing fuel utilization efficiency significantly beyond the approximately 1 percent achievable with present types of light water thermal reactors.

The FY 1984 Water Cooled Breeder budget request is $35.5 million.

Defueling Activities

In October 1982, the Shippingport plant ceased routine operation with the Light Water Breeder core and end-of-life testing and reactor defueling began. The Shippingport defueling effort will take approximately 2 years, ending in FY 1984. The overall defueling activities will continue until completion of fuel shipments from the Expended Core Facility (ECF) to the Idaho Chemical Processing Plant in 1987.

Efforts associated with the defueling process in FY 1984 include: maintaining the Shippingport plant and providing instrumentation, control, and electrical power system operational support for the light water breeder core defueling; completing core defueling, head area disassembly, fuel removal, and equipment disposal; disassembling fuel modules for shipment; continuing ongoing training of personnel at the Expended Core Facility in Idaho to receive and handle the spent fuel; continuing preparation of procedures and installation of equipment;

shipping the spent fuel and receiving the spent fuel modules at ECF; placing the shipping containers in the water pits, unloading the containers, and transferring the fuel to water pit storage receptacles.

Other defueling efforts will include: providing radiation analysis for component disposal and disposing of removed core components; shipping a spare fuel module and fuel rods to the Idaho Chemical Processing Plant for storage; and preparing the Shippingport plant for turnover to the DOE Office of Waste Management upon completion of the defueling and shipment of the spent fuel.

Assessment and disposal of components removed from the Shippingport reactor vessel prior to installing the light water breeder core will continue. This includes shipment of the lower core barrel from the previous core.

Core Evaluation

A detailed core evaluation at the Expended Core Facility is necessary to determine the condition of the core and establish the extent of breeding achieved. Core evaluation is expected to take 5 years.

During FY 1984, work conducted under the Core Evaluation subprogram will include: assessing end-of-life test data; publishing technical reports documenting the Shippingport Light Water Breeder Reactor performance; preparing for examination and proof-of-breeding work; and conducting work necessary to provide fuel rods for destructive analysis. Destructive analysis work is funded under the DOE Fuel Cycle Program.

CONVERTER REACTOR SYSTEMS

The overall goals of the Converter Reactor Systems Program are threefold: 1) to improve the efficient and safe use of converter reactors through improvements in Light Water Reactor (LWR) technology, 2) to contribute to the resolution of the nuclear industry's regulatory, financial, and institutional problems, and 3) to fulfill the Federal Government's research and development commitment associated with General Public Utilities' cleanup of Three Mile Island (TMI). In FY 1984, this program will focus on the following activities: 1) the Loss of Fluid Test (LOFT) facility; 2) research and development and information retrieval on TMI; 3) in-house regulatory, financial, and institutional analyses of obstacles to a healthy nuclear-electric industry; 4) coordination of a national LWR safety program; and 5) completion of work on a single LWR fuel design for extended burnup.

The FY 1984 budget request for Converter Reactor Systems is $53.2 million, down from $78.8 million in FY 1983. The following table reflects the breakout of these funding levels.

	(B/A in Millions) FY 1983	FY 1984
Light Water Reactor Systems	$ 10.0	$ 15.0
High Temperature Reactors	35.3	0.0
Three Mile Island Activities	29.0	37.0
Advanced Reactor Systems	4.2	0.0
Program Direction	0.3	1.2

Light Water Reactor Systems

Since FY 1976, the LWR program has been concerned with developing and demonstrating technical advances in the design, manufacture, and operation of LWRs in order to enhance their safe and efficient use as a source of base-load electrical energy. Today, the major problems confronting the nuclear reactor industry are no longer technical, but are institutional, financial, and regulatory in character and as such the FY 1984 Converter Reactor Program places more emphasis on these. The foremost priority in this regard is reform of the current, inefficient NRC licensing process. I will now briefly discuss each of the Converter Reactor Program activities.

Light Water Reactor Institutional and Safety Program

The proposed LWR safety R&D program has been reoriented to provide the technology base needed to support institutional improvements in the way nuclear technology is licensed and regulated. In particular, support for nuclear regulatory reform proposals and for satisfying the requirements of the Nuclear Safety Research, Development, and Demonstration Act of 1980 (Public Law 96-567 - to develop a technical basis to effect improvements in the ability of LWR industry to produce reliable, economic, and safe nuclear power) are provided for in the FY 1984 program plan.

Our objectives pertaining to regulatory reform fall into five major categories. First, approval of standard designs. This provision would authorize the Nuclear Regulatory Commission (NRC) to approve standard designs for entire plants or subsystems so that utilities have the option of choosing a plant of preapproved design in lieu of one-of-a-kind or customized plant design. The objective is not only a major improvement in both time and dollars required to review,.certify, and build a plant to meet the NRC's safety criteria, which will translate into lower costs to consumers, but an enhanced degree of public health and safety due to greater familiarity with the plant during its construction and operation.

Second, advanced site approval. This provision authorizes the NRC to approve sites for prospective nuclear plants in advance of a utility's decision to apply for permission to construct such a plant. The objective is to provide for earlier and more effective public participation in the site selection process before significant funds are expended, thereby reducing unnecessary expenses and costly planning uncertainties.

Third, integrated licensing procedures. This provision permits utilities to apply to the NRC for a construction and operating license in one proceeding in lieu of the current process whereby a construction permit and an operating license are obtained at different stages of the process. The objectives are more meaningful participation for the public, a more systematic and comprehensive review by the NRC, and greater predictability and certainty for utility planners.

Fourth, centralized review of proposed design modifications. This provision requires the NRC to provide for centralized review and approval of all backfitting proposals made by the NRC's staff. The objective is better prioritization and more logical sequencing of modifications that have been judged to offer significant safety improvement, thereby minimizing wasteful duplication of effort. In addition, criteria would be established which would require a design modification to result in a significant improvement in public health and safety when considered over the life of the plant before it could be incorporated. More attention would be paid to a proper balancing of costs to the consumer of plant backfits, and the potential improvements in their health and safety.

Fifth, improvement in the hearing process. This provision allows legislative hearings for most issues, thereby reserving adjudicatory hearings for contested issues of material fact. It also assures that issues already settled in other proceedings do not have to be reviewed again unless additional material facts are introduced. The objectives are to focus more time and resources of the NRC on substantive public health and safety issues, while at the same time permitting a more effective licensing process.

To satisfy the legislated requirements of the Nuclear Safety Research, Development and Demonstration Act, the Department will coordinate the development and implementation of a DOE/NRC/industry cooperative program to establish the priorities of institutional and technological safety issues and to determine how best to resolve these issues. The first step will be the development of a systematic and integrated approach to LWR safety.

The program is divided into two phases--a program definition phase and a program implementation phase. Program needs and priorities are being defined by utilizing working groups composed of representatives from DOE, NRC, industry, and national laboratories. DOE has convened ten of these working groups. Additionally, the three specific studies required by Public Law 96-567 (A Comprehensive Program Management Plan, The Need and Feasibility of a National Reactor Engineering Simulator, and the Sufficiency of U.S. Efforts to Provide Specially Trained Operators for Nuclear Plants) were submitted to the Congress in FY 1982.

Anticipated accomplishments in FY 1983 include:

- Continuation of work with utilities to improve plant operators response to accident conditions and ability to restore a plant to a normal operating condition.

- Completion by the Institute for Nuclear Power Operations (INPO) of job and task analyses for powerplant operators so that improved training programs can be developed for coping with accidents.

- Continuation of support for and coordination of working groups developing the national safety R&D program as required by P.L. 96-567.

Expected accomplishments in FY 1984 include:

- Support for the enactment and implementation of licensing and regulatory reform legislation.

- Development of specific solutions to the institutional and financial problems of nuclear electric utilities.

- Continued coordination of the national safety R&D program consistent with P.L. 96-567.

Since these activities can be accomplished with internal departmental resources, we are only requesting funding in FY 1984 for personnel positions.

Loss of Fluid Test Program

The LOFT program is an internationally funded activity. In FY 1984, this program will adapt the unique capabilities of the LOFT facility (which otherwise would be lost as current related NRC R&D programs are completed) to provide data necessary to reduce uncertainties in primary and containment system responses to severe transients and accidents. Nine tests are planned over a 3-year period with a final severe test to simulate actual fission product releases from a fuel melting accident. The program will be directed by a consortium of the participants and will rely heavily on input from the nuclear industry. The participation of industry is expected to result in a greater focus on economic as well as safety related improvements. It is estimated that program costs from FY 1983 through FY 1986 will be $93.5 million. Of this amount, $25.0 million is FY 1983 NRC LOFT program funds, $15.0 million is FY 1983 NRC funds related to LOFT decontamination and decommissioning that the NRC has committed but Congress has not yet appropriated, $30.0 million is new DOE program funds, and $23.5 million will be contributed by foreign countries.

LWR Extended Burnup

The Extended Burnup Program through FY 1983 has consisted of: first, major projects to evaluate the extended burnup performance of specific fuel designs. The evaluations were conducted by selected electric utilities that were teamed with each of five LWR fuel vendors. And secondly, several smaller projects to obtain basic data on extended burnup phenomena needed for design and licensing.

The planned accomplishments for the Extended Burnup program in FY 1983 include: 1) the continuation of efforts to obtain generic design and licensing data and other necessary supporting technology and 2) continuation by utility/vendor teams of major R&D projects on extended burnup in LWRs.

In FY 1984, the basic data effort will be continued using funding still available from prior years' appropriations. Some major cost-shared contracts to develop other fuel designs will be cancelled. These efforts will complete Government support of this subprogram. Private sector organizations such as the fuel vendors, utilities, and the Electric Power Research Institute will--if interest exists--conduct the balance of the previously planned program activities without Government assistance.

Light Water Reactor Radiation Dose Reduction Program

No funds are being requested for this program in FY 1984. The phaseout of ongoing projects is being carried out using funds provided in prior years.

High Temperature Reactor

Due to its advanced developmental status, a commercial plant in operation, and the lack of a compelling reason for a new converter reactor concept at a time when there is no market for proven LWRs, no funding for the High Temperature Gas-Cooled Reactor Program is proposed in FY 1984. The focus of the FY 1983 program will be to continue ongoing technology and conceptual design tasks for the steam cycle/cogeneration configuration of the Lead Plant design.

Application and related design and technology studies of advanced and higher temperature modular reactor systems will also be completed in FY 1983 and data will be retained for potential applications to numerous industries that are presently dependent on fossil energy sources. The program will come to an orderly closeout at the end of FY 1983.

NUCLEAR FUEL CYCLE

The Nuclear Fuel Cycle program provides for development and demonstration of advanced technology for reprocessing of irradiated fuels from nuclear power reactors. The program will address the stringent requirements associated with reprocessing Fast Breeder Reactor (FBR) fuels, including the higher thermal and radiation burdens, higher fissile content, sodium contamination, and heavier fuel assembly structures. Advanced development for FBR fuel reprocessing will also be available for use by future LWR fuel reprocessors. The technical program will focus on development and demonstration of reprocessing technology that will provide for reduced radiation exposure to workers, increased environmental protection, increased reliability, enhanced safeguards, and reduced costs.

In FY 1983, installation and testing of equipment in the Remote Operations and Maintenance Demonstration (ROMD) section of the Integrated Equipment Test (IET) facility--the "cold" prototype equipment test facility at Oak Ridge--will continue to evaluate performance and the ability of the equipment to be maintained remotely. Testing will include the continuous rotary dissolver, centrifugal contactors and manipulators needed for remote operations and maintenance. Also, the Integrated Process Demonstration (IPD) section of IET will be put into service. Support efforts will also proceed on instrumentation and control, analytical chemistry, environmental protection, radiation protection, safety and safeguards.

In FY 1984, development of critical components and systems that are to be remotely operable and maintainable will continue. The fuel disassembly and shear machine will be installed and undergo tests in ROMD. Testing of the industrial standard manipulator will continue and testing of an advanced design will be initiated. Conceptual design studies initiated in FY 82 will be continued, and engineering support in IET started, to examine alternative means of developing and demonstrating in a prototypic hot operational environment the necessary breeder reprocessing technology.

Efforts in FY 1984 will also include providing supporting analysis and evaluation for the LWBR proof-of-breeding demonstration, implementing a program to assure adequate means exist for handling and shipping irradiated breeder fuel, and managing the program (funded by ACDA in FY 84 and beyond) to develop alternate low-enriched fuel system for use in test and research reactors currently operating on highly-enriched uranium fuel.

In addition to R&D efforts, the Department is continuing to analyze the institutional impediments to commercial reprocessing of Light Water Reactor fuels, consistent with the directives in the President's nuclear policy statement of October 8, 1981. We have identified a number of major obstacles and will continue to work towards creating an environment in which private industry can again undertake efforts in commercial reprocessing with acceptable business and technical risks.

ADVANCED NUCLEAR SYSTEMS

The Advanced Nuclear Systems Program supports civilian and military space applications through the development of a range of nuclear power system options. Nuclear power sources have provided the electrical energy for the NASA Pioneer, Viking, and Voyager missions, as well as earlier lunar and earth orbital missions. Since 1961, the United States has launched 22 NASA and military space systems having all or part of their power requirements supplied by nuclear power sources.

The Advanced Nuclear Systems budget request for FY 1984 is $34,105,000, a $4,838,000 decrease from the FY 1983 appropriation. Distribution of the funds for Advanced Nuclear Systems is as follows:

Advanced Nuclear Systems	FY 1983 (in thousands)	FY 1984
Flight Systems Development	$17,170	$14,635
Flight Systems Support	20,792	17,100
Special Applications	0	1,000
Program Direction	981	1,370
Total	$38,943	$34,105

This activity is a direct application of the nuclear expertise within the Department of Energy to support approved United States missions of the National Aeronautics and Space Administration, the Department of Defense, and other Federal users.

In accomplishing the responsibilities and in keeping with related statutory requirements, the Department and its predecessor agencies have, over the years, developed a unique complex of laboratories and personnel dedicated to nuclear space power research and development, with a strong emphasis on working within established safety and environmental guidelines. These laboratories have degrees of expertise in producing special nuclear material, forming the isotope material into the desired chemical and physical state, analyzing the materials, and testing the fueled units. Because of the potential safety concerns associated with the use of special nuclear materials, the Department, its laboratories, and contractors have developed extensive expertise, equipment, and facilities for the safe handling of this material. It is because of these unique nuclear capabilities, plus the attendant health and safety responsibilities that the Department--as did the predecessor agencies--has the overall lead responsibility within the Federal government for the development of nuclear power sources for use in space.

In fiscal year 1984, the major undertaking will continue to be the development of the nuclear isotope power generators for use on the NASA Galileo spacecraft and on the NASA/European Space Agency (ESA) International Solar Polar spacecraft, both planned for launch in 1986.

Another major activity is the continuation of the space nuclear reactor power development program in cooperation with NASA and DOD. The objective of this program is to develop space nuclear reactor power sources capable of producing 100 kilowatts or more of electrical power. NASA missions involving nuclear electric propulsion, space stations, lunar operations, and planetary exploration and DOD applications involving communications, surveillance, electronic jammers, and space command defensive weapons will require power levels in this range.

Technology activities are planned to continue towards development of an Advanced modular isotope thermoelectric generator (MITG). This project will enter into the ground demonstration phase. It is envisioned that this generator, with its significant improvements in modularity and high specific power to weight ratio, will be the cornerstone to support the NASA planetary and DOD missions of the future.

Flight Systems Development

This subprogram element includes the design, development, fabrication, and assembly of the isotope space power converter subsystems for the NASA Galileo and NASA/ESA International Solar Polar spacecraft. Several flight converters are planned to be completed and shipped from General Electric, Valley Forge, Pennsylvania, to the Mound Plant, Miamisburg, Ohio. They will be supported by this subprogram element throughout the flight acceptance tests at the Mound Plant. The electrically heated engineering converter will be operated on a long-term endurance test, and technical support will be provided by General Electric to the Mound Plant on the endurance test of the isotope fueled qualification generator. The Final Safety Analysis Report for Galileo and the Updated Safety Analyses Report for ISPM are planned to be published. The Department is currently renegotiating the Interagency Agreements with NASA to include reimbursable work for both the qualification and flight spare units. NASA currently plans to reimburse the Department for all flight units delivered for the Galileo and ISPM mission.

Under the Space Reactor Development Program, which is funded within this subprogram, it is planned to continue component development and reactor concept design definition efforts. Several component subassemblies of the reactor core and heat pipes will undergo testing and analyses along with appropriate safety analyses and overall reactor core design efforts. Several thermal power levels will be examined to determine what type reactor subsystem warrants further development.

In FY 1983 the following efforts were accomplished:

Heat Pipe Reactor (HPR)

- Reactor design reviewed and refined
- Critical experiment performed
- Preliminary mechanical and thermal analyses performed
- Prototype core heat pipe tested at design conditions
- Materials compatibility tests in progress
- First in-pile experiment designed and approved for insertion into EBR-II in 1983
- Initial safety program plan completed
- Water immersion criticality studies performed

Alternative Concepts

Several study contracts were initiated to identify and evaluate alternative concepts. Final design selection will depend on results of ongoing and planned studies under the Space Reactor Development Program, and on Statements of Operational Needs of user agencies.

In FY 1984 the following activities are planned:

HPR

- Continue reactor design activities
- Continue development of material data base
- Continue development of critical component technology

Alternative Concepts

- Continue to evaluate alternative concepts

Flight Systems Support

This funding element supports fuel form production, encapsulation, heat source component manufacturing and assembly, environmental testing of the fueled flight units, and the overall independent safety and safety testing activities.

In fiscal year 1984, the following activities are planned:

- Conduct heat source assembly, fueling and flight acceptance testing of a Galileo,and an ISPM radioisotope thermoelectric generator (Mound Plant).
- Conduct independent safety analyses and safety testing (Los Alamos National Laboratory).
- Conduct independent quality assurance and quality control efforts plus independent technical support activities.

Special Applications

This subprogram covers design and integration studies, development tests on advanced radioisotope thermoelectric generator (RTG) components aimed at extending power system lifetimes and minimizing personnel exposure operations, and analyses of compact nuclear reactor powerplants at the request of the Department of Defense (DOD). These efforts are being conducted for application at various DOD facilities. In addition, general nuclear related studies, assessments, and nuclear training programs are also supported.

In FY 1984, the following activities are planned:

- Support system application studies of terrestrial RTG users by conducting power system trade-offs, integration studies, and performance analyses.
- Evaluate the potential of existing space system RTG technology and designs for applicability to terrestrial uses.
- Develop RTG design concepts for terrestrial applications, considering modularity for varius power levels and the potential environments.
- Evaluate modifications or changes to existing thermoelectric material and converter designs to increase reliability, lifetime, voltage requirements for particular applications, and efficiency.

Mrs. Bouquard. Our next witness is Mr. Kermit Laughon, Director of the Office of Spent Fuel Management and Reprocessing Systems. He will be followed by Mr. Gordon Chipman.

You may proceed as you wish, Mr. Laughon. We welcome you also to the committee.

STATEMENT OF KERMIT O. LAUGHON, DIRECTOR, OFFICE OF SPENT FUEL MANAGEMENT AND REPROCESSING SYSTEMS

Mr. Laughon. Madam Chairman, thank you very much. It is a pleasure to be here before your committee.

In the name of natural resource conservation, I have not prepared a separate statement to be submitted for the record.

Rather, in Dr. Brewer's rather extensive statement, there are some pages on the fuel cycle activity which I hope will suffice in terms of written testimony.

What I would like to do is offer some extemporaneous remarks regarding our program. First of all, with respect to what we are doing in fuel cycle R&D, and leading up to some discussion of the Barnwell situation.

Mrs. Bouquard. Please proceed as you wish.

Mr. Laughon. OK. As you can see on slide 9 the overall budget for fiscal year 1984 requested for fuel reprocessing R&D is about $34 million, essentially the same as fiscal year 1983.

NUCLEAR FUEL CYCLE FUNDING
($ IN MILLIONS)

	FY 1982		FY 1983		FY 1984	
	B/A	B/O	B/A	B/O	B/A	B/O
FUEL REPROCESSING R&D						
ADVANCED FUEL REPROCESSING	$25.1	$25.5	$23.4	$24.4	$32.4	$34.2
PROOF-OF-BREEDING	2.0	1.9	2.0	2.0	3.0	3.0
BARNWELL NUCLEAR FUEL PLANT	7.5	7.5	7.5	7.5	—	—
THORIUM FUEL CYCLE	3.0	3.0	2.5	2.9	—	—
SUBTOTAL FUEL REPROCESSING R&D	$37.6	$37.9	$35.4	$36.8	$35.4	$37.2
PROGRAM DIRECTION	$ 1.1	$ 1.1	$ .8	$ 1.0	$ 1.4	$ 1.4
TOTAL NUCLEAR FUEL	$38.7	$39.0	$36.2	$37.8	$36.8	$38.6

Slide 9

There is some restructure of the budget. You will note no funds are shown for the Barnwell facility or the thorium fuel cycle, but additional funds are being requested under the advanced fuel reprocessing line.

If I may, I would like briefly to take you through a discussion of some of the work which we are doing for the LMFBR fuel cycle program. Slide 10 summarizes the planned accomplishments. I will provide a copy of all visual aids for the record, Madam Chairman, but to facilitate the discussion, if I may, I would like to go now to a series of pictures and photographs which perhaps will illustrate much better than a word chart what it is we are accomplishing.

LMFBR FUEL CYCLE PROJECTS

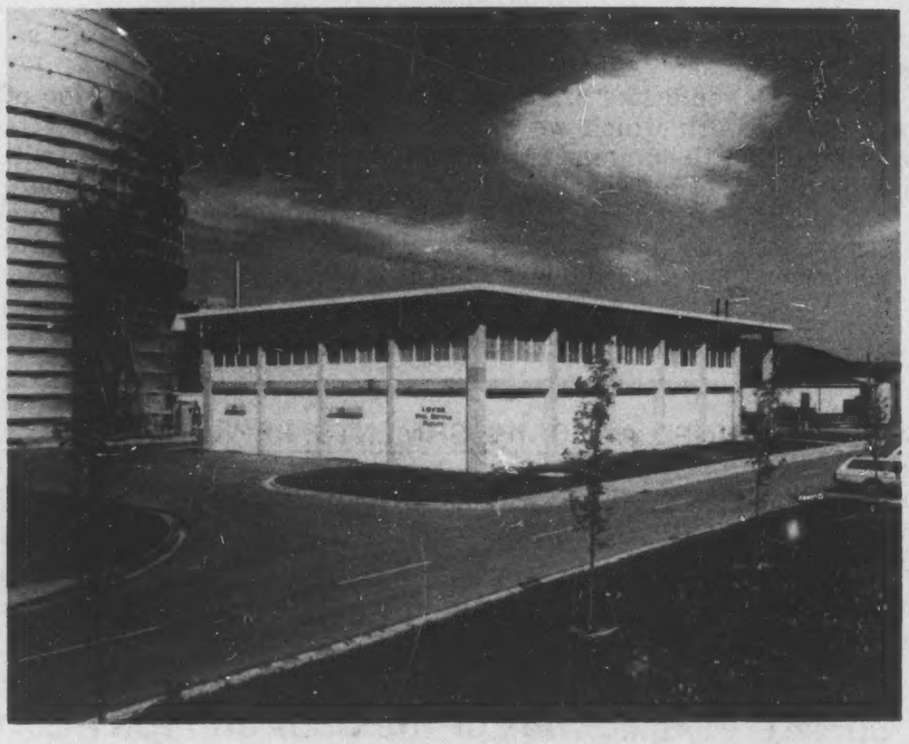
FY 1983 PLANNED ACCOMPLISHMENTS: REPROCESSING

- CONTINUE INSTALLATION OF EQUIPMENT IN THE INTEGRATED EQUIPMENT TEST FACILITY (IET)
- COMPLETE FABRICATION OF INDUSTRIAL STANDARD ELECTROMECHANICAL SERVOMANIPULATORS AND INITIATE TESTING
- COMPLETE FABRICATION OF THE IODOX UNIT FOR THE IET
- INSTALL SECOND 8-PACK CENTRIFUGAL CONTACTOR BANK IN THE REMOTE OPERATION AND MAINTENANCE DEMONSTRATION (ROMD) SECTION OF IET
- CONDUCT REMOTE MAINTENANCE TESTS WITH THE CONTINUOUS ROTARY DISSOLVER
- COMPLETE FUNCTIONAL AND MAINTAINABILITY TESTING OF REMOTE SAMPLER

Slide 10

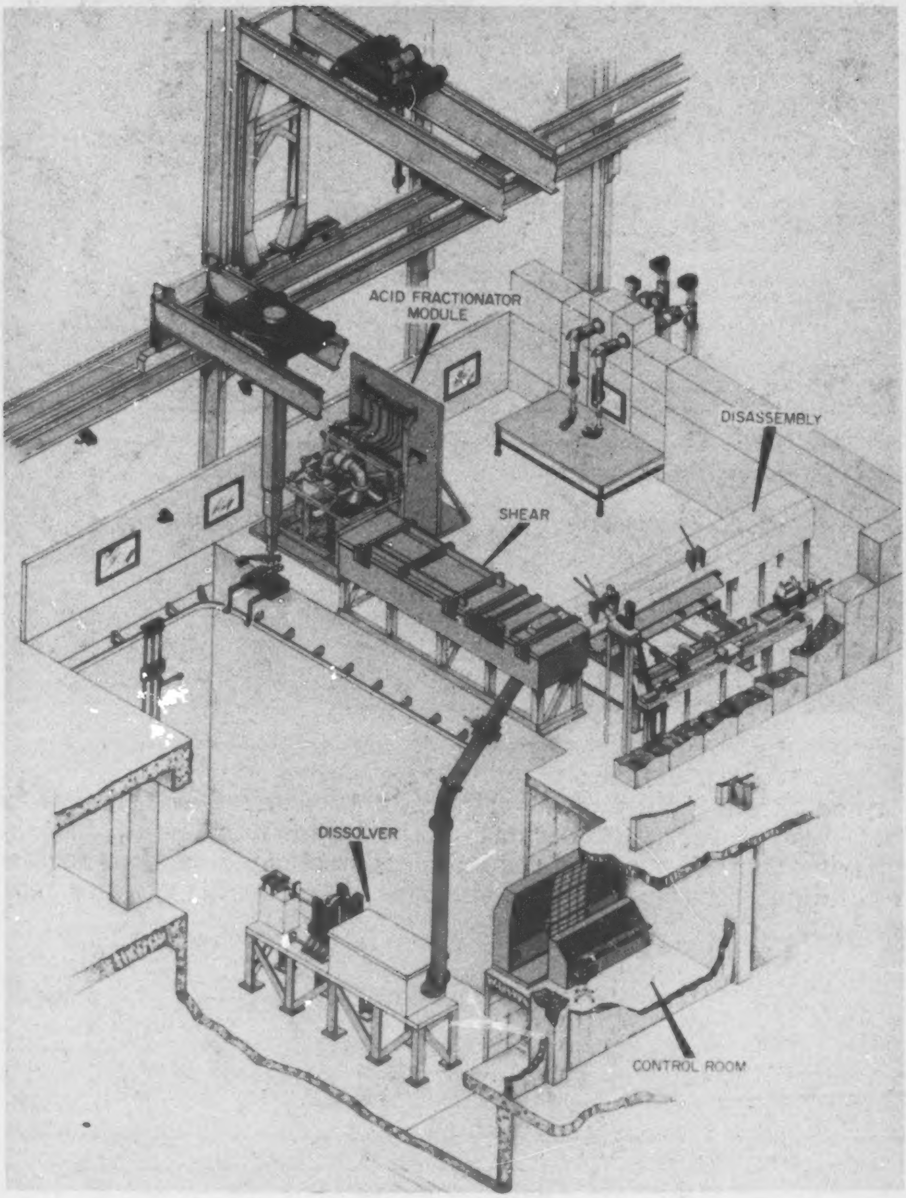
Mrs. Bouquard. Please proceed.

Mr. Laughon. The LMFBR fuel cycle work is being conducted primarily at the Oak Ridge National Lab in what is known as the consolidated fuel reprocessing program.



Slide 11

Within the facility shown in slide 11 we have just completed the Integrated Equipment Test Facility known by the acronym of IET, the purpose of this facility—shown in diagram in slide 12—is to allow the testing of large-scale breeder reprocessing equipment in a nonradioactive environment.

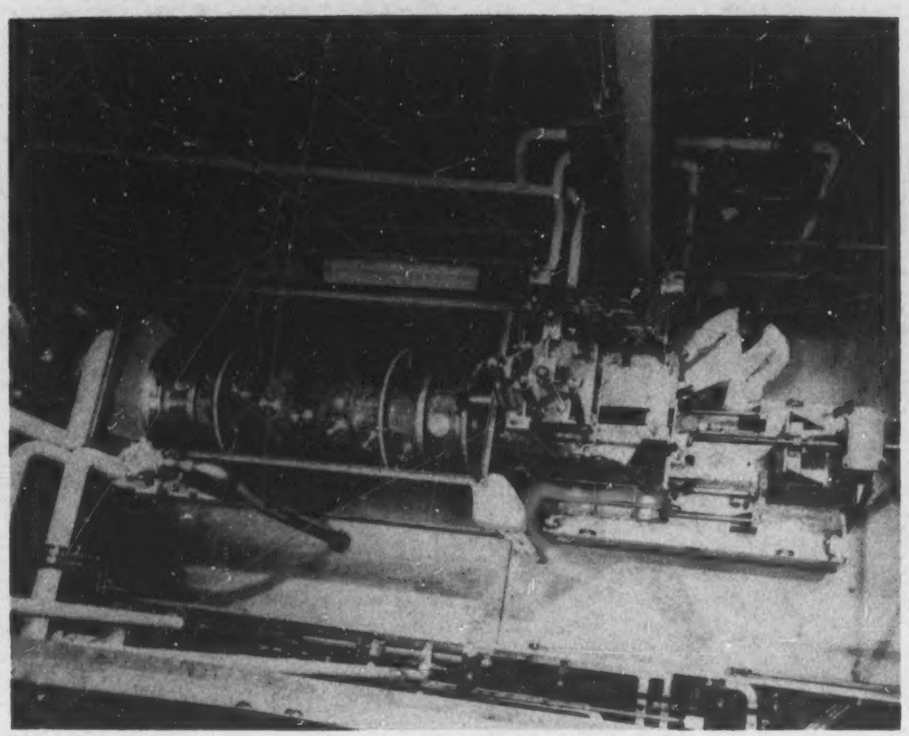

ACID FRACTIONATOR MODULE
DISASSEMBLY
SHEAR
DISSOLVER
CONTROL ROOM

Slide 12

For example, in this diagram [slide 12] you can see to the far right a fuel disassembly machine, a fuel element shear, a dissolver and an acid fractionator module.

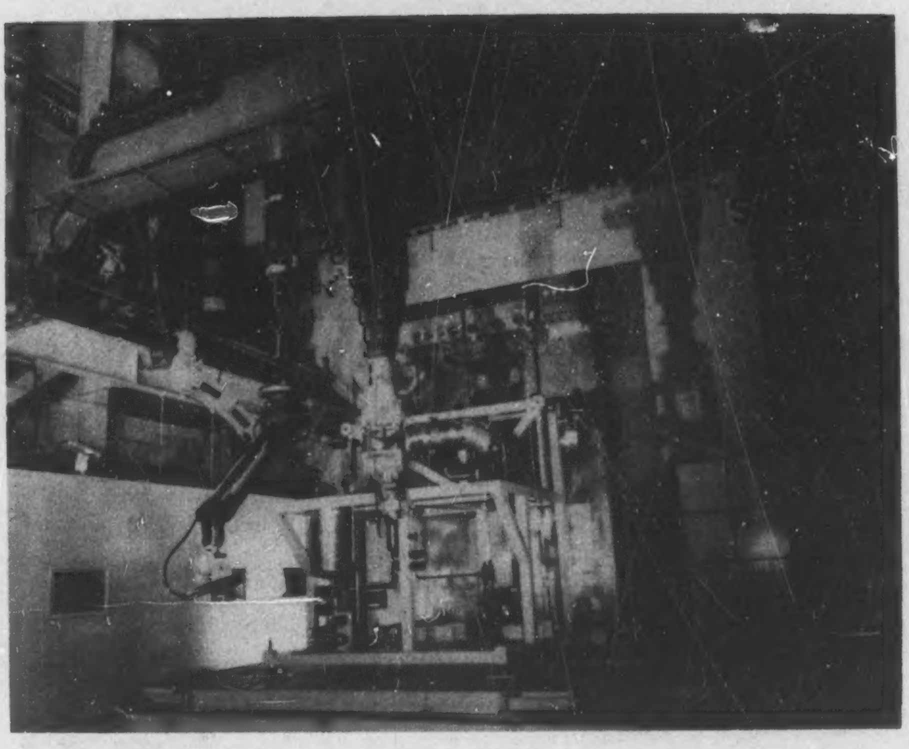
Slide 13

Slide 13 is a picture of a 250-ton prototype shear for fast breeder fuel. Fast breeder fuel, because of the larger number of pins, the different composition, and the stainless steel cladding, does require a different technology for the shearing than does light water reactor fuel.



Slide 14

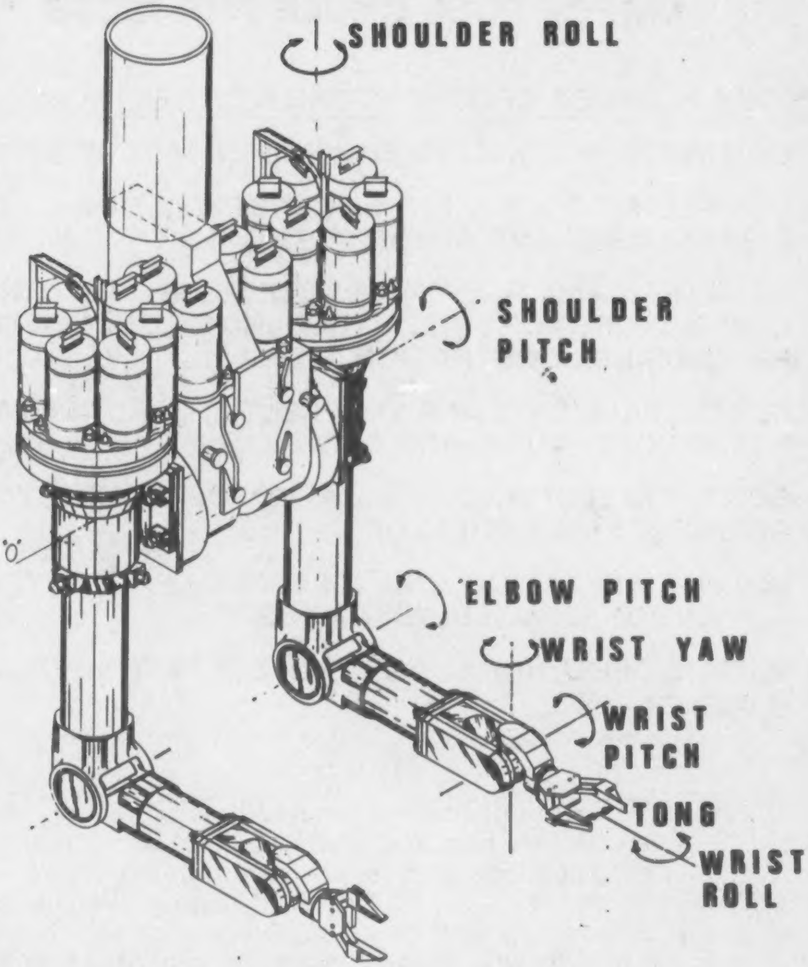
Slide 14 is is a picture of a prototypical rotary dissolver. After a fuel is sheared, it would be dropped into an acid solution and dissolved prior to being moved to the solvent extraction stages for separation of the uranium, plutonium, and fission products.



Slide 15

The advanced servo manipulator equipment which is being developed and will be tested within the IET is shown on Slide 15. This type of equipment represents an advancement in state-of-the-art technology for remote handling in that what we have is the best in modern electronics, the best in modern engineering.

Truly, the best technology in the world.


SHOULDER ROLL
SHOULDER PITCH
ELBOW PITCH
WRIST YAW
WRIST PITCH
TONG
WRIST ROLL
O

ADVANCED SERVO MANIPULATOR

Slide 16

Slide 16 is simply a diagram to again illustrate how manipulators are now being developed which come very nearly being capable of reproducing all the actions that the human arm, wrist and fingers can do in terms of twisting, rotating, picking up things; it is really the advanced maintenance concept of the future.

LMFBR FUEL CYCLE PROJECTS

FY 1984 PLANNED ACCOMPLISHMENTS: REPROCESSING

- COMPLETE INTEGRATED EQUIPMENT TEST (IET) PROJECT
- COMPLETE FABRICATION AND INSTALLATION OF FUEL DISASSEMBLY AND SHEAR SYSTEMS
- COMPLETE REMOTE MAINTENANCE TESTS ON CENTRIFUGAL CONTACTORS FOR FIRST CYCLE; INSTALL IN INTEGRATED PROCESS DEMONSTRATION (IPD)
- DESIGN, FABRICATE AND TEST CENTRIFUGAL CONTACTORS FOR SECOND AND THIRD CYCLES IN IET
- CONTINUE TEST AND EVALUATION OF INDUSTRY STANDARD MANIPULATOR
- INITIATE OPERATION AND TESTING OF PROTOTYPE ADVANCED SERVOMANIPULATOR
- INITIATE OPERATIONAL AND PROCESS TESTING OF REMOTE SAMPLER

Slide 17

Our planned accomplishments for fiscal year 1984 are shown on slide 17. Given that we have completed the line item project for the IET facility at Oak Ridge, and we are very proud of it, we are looking forward to beginning some equipment testing. We will go ahead and install disassembly and shear machines such as I have shown you pictures of. We will do some work on centrifugal contactors. We will continue to do the work on the manipulators, and we will get into the testing of remote sampling devices.

I would note that one change which we are making in the major thrust of this program is that we are now looking at concept of developing smaller scale equipment such as might be needed perhaps for the FFTF fuel in Hanford, Wash.

We believe the IET facility is a crucial element of this program, and that there will likely be a need for smaller scale reprocessing equipment to support the breeder program substantially before the number of large scale breeders would be such to justify a full scale commercial plant.

LMFBR FUEL CYCLE PROJECTS
LIGHT WATER BREEDER REACTOR-PROOF OF BREEDING/ ANALYTICAL SUPPORT

PLANNED ACCOMPLISHMENTS

FISCAL YEAR—1983

- FULL-SCALE SHEAR & TOOLING INSTALLED AND CHECKED-OUT BY JULY
- DUAL-DISSOLVER SYSTEM INSTALLED AND CHECKED-OUT BY JULY
- ANALYTICAL INSTRUMENTATION OPERABILITY VERIFICATION BY AUGUST
- DATA MANAGEMENT SYSTEM OPERABILITY VERIFICATION BY SEPTEMBER
- WASTE MANAGEMENT EQUIPMENT INSTALLED AND CHECKED-OUT BY SEPTEMBER

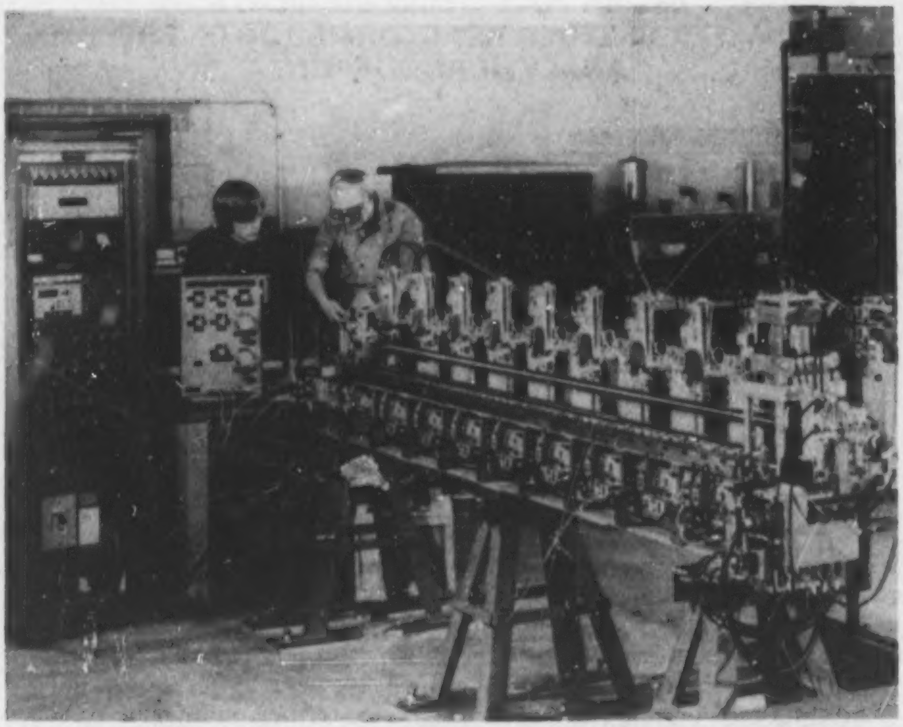
FISCAL YEAR—1984

- VERIFY PERFORMANCE OF EQUIPMENT AND ANALYTICAL PROCEDURES BY COMPLETING ANALYSIS OF VALIDATION ROD II
- INITIATE PLANNED ANALYSES OF NR-SELECTED END-OF-LIFE FUEL RODS DISCHARGED FROM THE SHIPPINGPORT-LWBR REACTOR
- INITIATE PROCESSING AND PACKAGING OF HIGH-LEVEL WASTES GENERATED WITHIN THE POB ANALYTICAL SUPPORT PROJECT

Slide 18

Slide 18 shows planned accomplishments in the proof-of-breeding program, which, as you know, we are conducting in support of the light water breeder program.

Basically it is our plan by the end of fiscal year 1983 to be in a position to carry out the measurements which are planned on fuel from the Shippingport reactor, and, as indicated on this chart, we would expect to actually do some of those measurements in fiscal year 1984.



Slide 19

Slide 19 is a picture of the high-precision shear for the proof-of-breeding program. The shear has been developed at the Argonne National Laboratory to allow for very careful shearing and dissolution of fuel pins from the Shippingport reactor so that the breeding performance can be measured very carefully.

Now, with that, I would like to move to the subject of the Barnwell nuclear fuel plant, shown on slide 20.

Slide 20

Dating back to March 1981, the administration's position has been that reprocessing of the light water reactor fuels should be primarily the responsibility of the private sector.

We in the Department of Energy were charged with identifying regulatory barriers and impediments, and trying to develop recommendations to foster an environment in which private industry could move forward with reprocessing.

As Dr. Brewer has indicated and as I must reiterate, this is one area in which we cannot sit before you and say that we have found the solution and that we are moving forward. Basically there are many uncertainties.

NEED FOR REPROCESSING

Long-Term

- **Contributes to More Secure Energy Future**
  - **Necessary for Breeder**
  - **96% by Weight of Spent Fuel is Reusable (0.8% U-235, 0.7% Fissile Pu, 94.5% U-238)**
  - **Necessary for Mixed Oxide Recycle in LWR, If and When Appropriate**
- **Serves Nonproliferation Objectives Through Leadership**
- **Waste Disposal Benefits**
  - **Permits Disposal of Only Unusable Portions of Spent Fuel (4%)**
  - **Permits a Waste Form Engineered for Disposal**
  - **Shortens Necessary Isolation Period**

Near-Term

- **Provides Pu for FFTF, CRBR, and Other Breeder Program Needs**
- **Reduces or Eliminates Need for Special Spent Fuel Storage Facilities**
- **Strengthens International Marketing of U.S. Power Reactors**
- **Signifies an Important, Practical Step Forward Toward an Advanced Nuclear Economy**
  - **Helps Recreate a Positive Environment for Nuclear Power**

Slide 21

They have to do with everything from the need for reprocessing to the current economic and regulatory environment which faces the nuclear industry. What I would like to do is touch briefly on the need for reprocessing of light water reactor fuels as summarized on slide 21.

For the long term, it is needed to conserve uranium resources. With the light water reactor operating on a once-through fuel cycle, you get something like 1 percent or less of the energy content from uranium. With the breeder reactor you have the opportunity to increase that hundredfold or 10,000 percent. That was the classic argument for the breeder. It still is.

Second, we believe that we in the United States need to be active in the civil reprocessing field if we are to have influence over similar activities in other countries. Only by being involved in a technology are we in a position to actively work with and influence what other countries may choose to do with their spent fuel.

Third, there are waste disposal benefits. Clearly, if you can separate out only the 4 percent or thereabouts of true fission product wastes and bury those, and reclaim the 96 percent of reusable material, you should have a waste disposal benefit. Further, by separating it, putting it into a form that is especially engineered for disposal, it should make the job of long-term isolation substantially easier.

Next, removing the long-lived actinides from nuclear waste can shorten the period of required isolation from several thousand years to a period of 600 to 1,000 years.

In the near term we could use the recovered plutonium for the FFTF, Clinch River, and other breeder R&D, although there is material available within the DOE stockpile. Near-term reprocessing at the Barnwell plant would remove the need for any new Government spent fuel storage facilities since startup and operation of that plant in 1990 would effectively handle the spent fuel storage problem through the year 2000.

Next, I think it is fair to say that U.S. industry would be served well by being put in a position of being able to compete more favorably with other nations who offer nuclear power reactors and fuel cycle services.

Finally, moving on with reprocessing signifies an important step toward an advanced nuclear power economy.

The barriers to reprocessing are given on slide 22.

GOVERNMENT BARRIERS TO COMMERCIAL REPROCESSING

- **Regulatory Barriers**
  - **Procedural**
  - **Technical**
- **Potential for Future Changes in Government Policy**
- **Unique Economic Uncertainties**
  - **Allowed Uses for, Hence Value of, Plutonium**
  - **Costs and Schedule for Federal Waste Disposal**
  - **Transportation Issues/Costs**
  - **Time and Cost for Licensing**

Slide 22

Mr. LAUGHON. There are clearly regulatory barriers which date back to the early 1970's and the GESMO proceeding regarding mixed oxide recycle. There has been no active work in the licensing of reprocessing for about 5 years, so there is no new experience.

So there are uncertainties as to what it would take for the private sector to move forward in the licensing area.

Next, there is the potential that once again, industry, should they attempt to move forward, might face a situation in which they would be told by the government that reprocessing is prohibited, and would as a result lose hundreds of millions of dollars. These unique economic uncertainties need to be treated in detail.

What will we do with the plutonium, what is the value of it, what are the costs and schedule of Federal waste disposal? That issue should be resolved to a large extent through the waste-management act.

There are issues about time and costs for licensing, and transportation issues and costs. Over the past year in numerous informal discussions, there have been many suggestions as to what the government could do to foster commercial reprocessing. Possible actions are given on slide 23.

POSSIBLE GOVERNMENT ACTIONS

- **Offer to Negotiate Means for Protecting Against Future Policy Changes Regarding Reprocessing**
- **Request NRC to Consider Regulatory Reforms for Licensing Reprocessing Plants**
- **Develop Procurement Plan for Plutonium Purchases for U.S. Breeder Program and Mixed Oxide Recycle Investigations**
- **Establish Criteria, Schedule, and Cost for Waste Acceptance by U.S. Government:**
    - **Identify Waste Form**
    - **Identify Firm Date for Waste Acceptance**
- **Develop Overall Policy Regarding Foreign Participation in U.S. Reprocessing Efforts, as Desired and Appropriate**
- **Assist in Discussions Between Commercial Reprocessers and Affected State and Local Governments, as Desired and Appropriate.**

Slide 23

We could provide some form of protection against policy changes which could range from something under existing law, to new legislation. We could work with the NRC to clarify the regulatory environment. We could make a determination on what we are going to do with plutonium, and possibly procure some on an economic basis for use in the breeder program.

We could establish firm costs and schedules under which a reprocessor could deliver his wastes from a reprocessing plant. There have been discussions about possible foreign participation and joint ventures. We could consider a national policy to deal with that question. Or we could assist, as appropriate, in discussions with affected State and local governments.

But what I must say to you is: These are possible Government actions. I can only reiterate what Dr. Brewer has said. It is impossible to work this problem in the abstract. Until the Government has an industrial entity sitting across the table, prepared to negotiate, it is not clear exactly how you get from here to there.

Some informal discussions with industry have suggested that we should use Barnwell as a research and development facility, and that the administration should not take the stance that reprocessing must be a private-sector venture.

On the other hand, as one of the representatives of the administration, I can only reiterate that at the present time that is the administration's position is that reprocessing should be a private sector venture.

STATUS OF INDUSTRY INTEREST

- **U.S. Reprocessing Companies Have Lost Millions of Dollars and View the Risks of New Ventures as Being Very Large**
- **U.S. Utilities Face Many Problems with Nuclear Power Plants and Have Differing Views on Reprocessing**
- **One Year Ago, Industry was Uniformly Negative About the Prospects for Private Sector Reprocessing**
- **Some Industry Attitudes Are More Positive Today, Though Cautious**
- **Foreign Companies Might Be Willing to Participate in U.S. Reprocessing Ventures Given Right Circumstances**
- **Attitudes of Current Barnwell Owners are Key to the Future of That Plant**

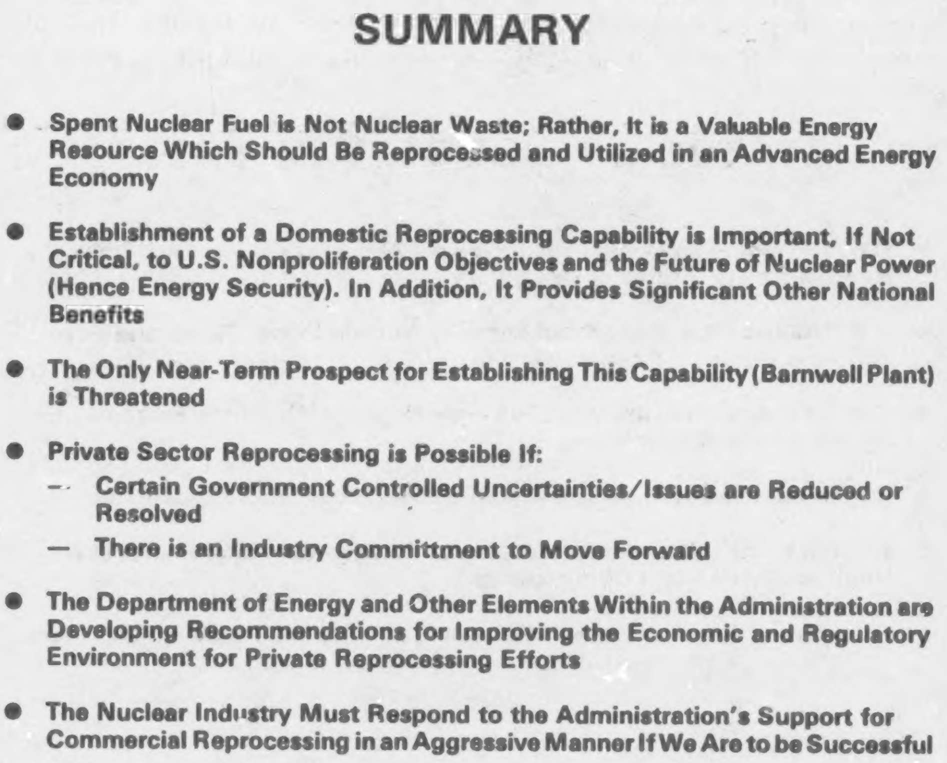
Slide 24

Our view of the industry is shown on slide 24.

Where do we believe industry stands? Traditionally reprocessing companies such as NFS, GE, Allied, Gulf, AGNS, and Exxon, have already lost millions of dollars and for the most part have made it clear that under the current environment they do not care to risk additional investments in reprocessing ventures.

Utilities have differing views and differing problems. There are some who support the concept of reprocessing, particularly if it would help resolve near term spent fuel storage problems. It would be incorrect to say that all utilities think alike. A year ago I believe industry was uniformly negative. Today, some industry attitudes are positive, but extremely cautious.

Foreign countries might be willing to participate under the right circumstances. But really, given the restraints that have been placed upon us regarding the Barnwell plant, namely, that we are to discontinue Federal funding for any activities at that plant beyond July 31 of this year, the attitudes of the current owners and the industry who might be prepared to become involved in this endeavor are the key to the future of that plant.



SUMMARY

- Spent Nuclear Fuel is Not Nuclear Waste; Rather, It is a Valuable Energy Resource Which Should Be Reprocessed and Utilized in an Advanced Energy Economy
- Establishment of a Domestic Reprocessing Capability is Important, If Not Critical, to U.S. Nonproliferation Objectives and the Future of Nuclear Power (Hence Energy Security). In Addition, It Provides Significant Other National Benefits
- The Only Near-Term Prospect for Establishing This Capability (Barnwell Plant) is Threatened
- Private Sector Reprocessing is Possible If:
  - Certain Government Controlled Uncertainties/Issues are Reduced or Resolved
  - There is an Industry Committment to Move Forward
- The Department of Energy and Other Elements Within the Administration are Developing Recommendations for Improving the Economic and Regulatory Environment for Private Reprocessing Efforts
- The Nuclear Industry Must Respond to the Administration's Support for Commercial Reprocessing in an Aggressive Manner If We Are to be Successful

Slide 25

Slide 25 summarizes the commercial reprocessing situation. Spent nuclear fuel is not nuclear waste, only some 4 percent by weight of spent fuel should be considered waste. The rest should be saved and reutilized in an advanced engineering economy. We believe that establishment of domestic reprocessing capabilities is very important to our U.S. nonproliferation policies and the future of nuclear power in this country.

The Barnwell plant is threatened by the possible loss of Government and industry support this year, as you know. Nevertheless, private sector reprocessing is possible if the Government can provide the required guarantees and make the risks acceptable. And if the industry is willing to make a commitment. We have been working for many months, more than I wish it had been, to try to determine how to move forward.

The nuclear industry must respond to the administration's efforts to date if we are to find a way to move forward with reprocessing, and specifically reprocessing at the Barnwell plant.

I would be pleased to answer any questions.

Mrs. BOUQUARD. Thank you very much, Mr. Laughon. That was a very fine testimony. We appreciate you being with us today.

One of the matters I wanted to touch on, in 1965 a report was issued by Battelle Pacific Northwest Laboratories that claimed that 1 ton of spent fuel contained products valued at $232,000. Is this your estimate of today's value?

Mr. LAUGHON. Madam Chairman, I am not personally familiar with that report. But let me offer you an answer and perhaps provide additional information for the record. In terms of looking at the value of spent fuel, it is noteworthy that much of the fuel now being stored had very low burnups and consequently, still contains very high residual enrichments; perhaps worth as much as $200 per kilogram of heavy metal.

In addition to that, if you put a value on the plutonium of about $6 a gram, there are about 7 grams of plutonium typically per kilogram of light water reactor spent fuel; then the plutonium is worth about $45 per kilogram of heavy metal. $200 plus $45 equals $245. I can see where by simple arithmetic such as I have offered, one could come up with values approaching the $250 range, easily.

Mrs. BOUQUARD. In the what range?

Mr. LAUGHON. $250 per kilogram, or back to your question, $250,000 per ton of spent fuel.

Mrs. BOUQUARD. I agree with you that we cannot have a nuclear economy without reprocessing. The best way to get rid of our waste is to burn it. I certainly was encouraged by your testimony. It has been said that the Soviet Union has the most effective nonproliferation policy in the world because they maintain positive control by producing their fuel assemblies and shipping them to reactors or leasing them out, then transporting them back to Russia for reprocessing. Would you like to comment on that?

Mr. LAUGHON. Well, clearly, Madam Chairman, since the earliest days of the development of civilian nuclear power, there has been the recognition that there have to be adequate controls put on the plutonium to be recovered from these machines. That is a basic premise on which the atoms for peace program was begun in this country in 1958.

The Soviet Union, of course, has their way of doing business. Clearly, by shipping fuel out and demanding it back, they control plutonium. But the nonproliferation subject itself is quite complicated in that there are several ways in which countries can acquire nuclear weapons.

To my knowledge, no country acquired a nuclear weapons capability from a power reactor. If I understand it correctly, in every case nuclear weapons were constructed first. Only then have we turned to the use of nuclear power for the peaceful benefit of mankind, as well.

The key to the control of plutonium should probably remain in the hands of the Government. I believe it would be that way in this country or in any other country which chooses to deal with it.

Mrs. BOUQUARD. How great do you think are the prospects for cooperative work with foreign countries in, say, what we are trying to do at Barnwell?

Mr. LAUGHON. The people in South Carolina are extremely concerned about the possibility of importation of spent fuel or nuclear wastes into their State. At this time we do not have a national policy to promote or oppose foreign involvement at Barnwell. I think the citizens of South Carolina would have to be convinced, as I have said consistently in previous discussions on this subject, that operations of the Barnwell plant are in their best interests.

Further, should there be any foreign involvement in the Barnwell plant, that must be in their best interest. There is known to be great concern in the State over that subject.

Mrs. BOUQUARD. What R&D work in photochemical and laser chemistry can further be done to advance the state of reprocessing if we move ahead with future operation of Barnwell? Do you think the separation process can be improved so we can further reduce the high level of wastes that we are going to have for disposal?

Mr. LAUGHON. At the present time the separations portion of the Barnwell plant is essentially completed with only some minimal upgrades required before that portion would be prepared to run. The flow sheet and equipment for Barnwell are based on the classic PUREX process.

Mrs. BOUQUARD. Would you explain that? We have some new members on our committee.

Mr. LAUGHON. PUREX is an acronym for plutonium uranium reductive extraction processing. It is the chemical process by which fuel elements are chopped up, dissolved in nitric acid solutions, and then contacted with various organic solutions. And, through a series of chemical interactions and stages, the process separates out the uranium, and plutonium, and fission product into separate streams which can then be treated and dealt with.

The PUREX flow sheet is the basis for the design of Barnwell. What does not now exist there is what will be required at some point in time for handling the liquid waste streams and perhaps for the conversion of plutonium nitrate to a solid oxide.

In answer to your question, it is not immediately clear to me what could be done in a photochemical or laser partitioning area at Barnwell except that based on some work at Los Alamos, there has been great interest in seeing what might be done with lasers to separate out specific waste products for use in nuclear medicine or whatever.

There is potential. I am not sure what the potential is at Barnwell.

Mrs. BOUQUARD. Thank you very much.

Mr. Ottinger.

Mr. OTTINGER. First let me put on the record that I don't agree that the dangers attendant in reprocessing are worth pursuing unless an urgent need is demonstrated. What plans does the Department have at the present time for exporting reprocessing equipment?

Mr. LAUGHON. Every request which comes to us from U.S. industry for foreign work in technologies which are defined as sensitive nuclear technologies requires an approval by the Secretary of Energy under 10 CFR 810. There have been requests made to the Government in the past by American companies which were seeking to work with other countries such as Japan and Germany in areas which fall under the category of sensitive nuclear technology.

But we in the Government, Mr. Ottinger, have no specific plans for exporting reprocessing technology.

Mr. OTTINGER. It was reported in the press at one time that such a sale was in fact being contemplated; just a few months ago. To your knowledge, there is no activity along these lines to sell reprocessing to Japan or other countries?

Mr. **Laughon**. At one time several months ago, really as a result of the efforts of the AGNS staff, there was under consideration a joint international safeguards run to be done at the Barnwell plant, possibly to involve the Japanese and Germans as well as the United States. That did not come to pass. It had arisen primarily again at the initiative of the AGNS staff. To my knowledge there are no plans for that work at this time.

Mr. **Ottinger**. What about enrichment? There were also plans to sell enrichment facilities and equipment to Japan. Are those active?

Mr. **Laughon**. I must defer to others on the subject of enrichment. That is not one of my responsibilities. If you would address that question to Mr. Voigt, I think you would——

Mr. **Ottinger**. I wouldn't be able to stay. If we could have that question answered for the record, I would appreciate it.

Mrs. **Bouquard**. Without objection it will be made a part of the record, Mr. Ottinger.

[The information follows:]

There are no efforts to sell enrichment equipment or facilities to the Japanese at this time.

Mr. **Ottinger**. Thank you very much, Madam Chairman.

Mrs. **Bouquard**. Mr. Valentine.

Mr. **Valentine**. Madam Chairman, I would like to ask him one question. I guess it is the question of a novice. But does your agency or department, sir, have any jurisdiction or responsibility in connection with the use of nuclear engineering other than for weaponry in the Armed Forces; that is, the nuclear powered aircraft carriers and submarines? Do you have any function in connection with that use of nuclear engineering?

Mr. **Laughon**. Yes, sir, the naval reactors program falls under the responsibilities of Dr. Brewer. At DOE, we do have the naval reactor program as well as defense weapons program.

Mr. **Valentine**. But that policy with respect to reprocessing or other responsibilities in the area of safety, for example, in that use of nuclear power, would still be subject to control by the Department of Energy.

Mr. **Laughon**. For Department activities, we do have our own rules and regulations regarding safety and environmental protection. For things such as reprocessing at the Barnwell plant, should that go forward as a commercial venture, that would basically fall under the auspices of the Nuclear Regulatory Commission which has responsibility for safety and regulation of all commercial nuclear activities.

To the extent that we were involved in taking plutonium and/or wastes from such a venture, I would expect there would be some very closer interfaces, though.

Mr. **Valentine**. Thank you, sir.

Mrs. **Bouquard**. Thank you very much.

Mr. Laughon, thank you very much for being with us today.

Mrs. **Bouquard**. Our next witness is Mr. Gordon Chipman. We welcome you, Gordon. We have your prepared testimony. You may proceed as you wish. Your entire statement will be made a part of the record of the hearings for today.

STATEMENTS OF GORDON L. CHIPMAN, JR., DEPUTY ASSISTANT SECRETARY FOR BREEDER REACTOR PROGRAMS, ACCOMPANIED BY JOHN LONGENECKER, ACTING DIRECTOR, OFFICE OF BREEDER DEMONSTRATION PROJECTS, AND WILLIAM NELSON, ACTING DIRECTOR, OFFICE OF BREEDER TECHNOLOGY PROJECTS

Mr. CHIPMAN. Thank you, Madam Chairman. It is a real opportunity to be here again.

I want to ask the two office directors that work for me in the breeder program to come forward. On my right is John Longenecker, Acting Director of the Office of Breeder Demonstration Projects. On my left is Bill Nelson, who is Acting Director of the Office of Breeder Technology Projects.

Mrs. BOUQUARD. We welcome all of you to today's hearings.

Mr. CHIPMAN. Madam Chairman, Dr. Brewer's testimony contained a rather lengthy list of information. In addition, I have a formal statement to submit for the record. With your permission, I would like to summarize in about 15 minutes the basis for this testimony.

Mrs. BOUQUARD. Please proceed.

Mr. CHIPMAN. Thank you.

In addition to summarizing the program itself, I think it is appropriate that I spend some time to discuss the basic philosophy and need for the breeder. From the questioning this morning and from the events of last year in the Congress, it became clear that the debate over the breeder is beginning to focus not on the issues that were historical in nature but more on new ones that have arisen.

It is unfortunate Congressman Ottinger wouldn't be able to be here. From his previous questions it is clear that is where his interests lie. But I would like to address those matters.

The current world oil glut and recent decline in U.S. electricity demand have raised many questions about the need for a national program to continue development of breeder reactors for electricity generation. In answering these questions we have to recognize that the need for long term planning and long gestation periods necessary for developing new commercially viable technologies require that the breeder program be examined in light of the long term energy picture, rather than short term trends.

In the decade since the first oil shock, nations and industries have funded a number of programs to find and developing both conventional energy resources and new energy technologies. Yet the situation is not much different today than it was 10 years ago.

While a slow economy and energy conservation have served to depress growth in the energy demand, the underlying long range facts remain the same. The Nation's most heavily relied-upon resources of energy, oil and natural gas, are the most limited in supply. Alternative technologies are ether too expensive, too limited or too immature to have significant national importance in the foreseeable future.

Very little has changed from the international perspective, either. Thus, the need to find large and economic energy supplies remains critical, with electricity being the area of greatest concern for the long term.

The United States, like other industrialized nations, is steadily becoming more dependent on electricity to sustain economic growth. Even in the conservation-minded 1970's, the demand for electricity increased by 50 percent while the total end use consumption of other direct forms of energy remained essentially unchanged.

Though the past decade has apparently altered the traditional link between overall energy use and economic growth, the link between electricity and the economy has remained generally strong. Accordingly, the slower growth in electric demand in recent years—actually negative last year for the first time in 30 years—accompanied a slow national economy.

This relationship has important implications for an improving economy. When economic growth returns to healthy levels, the growth in demand for electric power would be at least as high. A 3-percent average annual increase in electric power demand would call for a doubling of our national electric power capacity which is now almost 650 gigawatts in only 23 years.

Furthermore, some 25 percent of the Nation's current steam electric capacity is more than 20 years old. It will become increasingly uneconomic to operate. Thus, replacement plants will be required in addition to the new plants needed to satisfy increased demand.

Now, of course, future electric growth projections like economic growth projections are highly uncertain. However, the reasons for the likelihood of the continued long-term importance of electricity can be found in the convenience of electric power to the consumer; in the relatively low price of electric power, a price which has been increasing more slowly than other energy costs; and in the evolution away from other industry toward greater reliance on service industries which are more dependent on electricity.

The amount of domestic primary energy devoted to electricity production has increased from 20 percent in 1960 to 33 percent today and many forecasters expect it to increase to as much as 40 to 50 percent by the end of this century.

Thus, electricity will play an increasingly important role in most energy sectors and especially in the modernization and renewed competitiveness of the Nation's industries. For this reason, the Federal Government recognizes that adequate supplies of economic electricity are strategically important to the United States both domestically and internationally.

The availability and producibility of primary energy sources are a dominant issue in preparing for the future. However, many traditional means for producing electrical energy cannot be counted on to meet that growing need. Remaining sites for large hydropower plants are severely limited. Oil and natural gas, attractive as peaking power options, are generally not regarded as economic fuels for major new base load electric power stations.

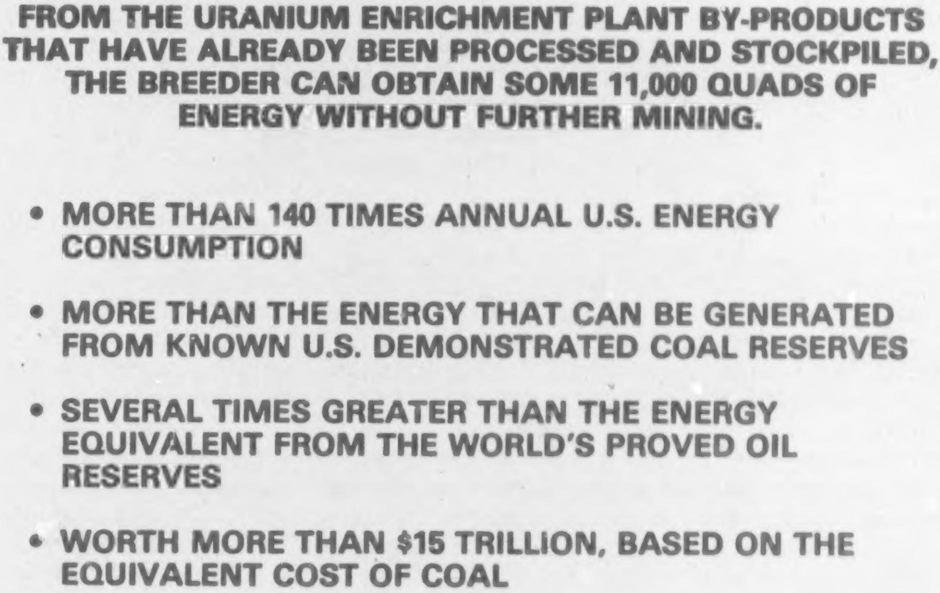
And exotic alternatives like synfuels, geothermal and fusion are too expensive, too limited, or too immature to have significant national importance in the near future.

That statement is not intended as a criticism of these technologies but a realistic assessment of their potentials, an assessment put forth by many groups, such as the National Academy of Science and others. The United States is left with only two energy sources: coal and nuclear energy. Of course, coal resources are plentiful. Scarcity will not limit its use, but coal contribution may be limited by production and transportation capabilities as well as environmental concerns.

In contrast, economic uranium resources to fuel conventional light water reactors are more limited than coal. As a result, nuclear power cannot be considered a long-term contributor to our electricity supply without a commercially viable means of significantly extending this resource, a conclusion that points to the importance of the breeder reactor.

Nuclear power with reliance on breeders is the one advanced technology that could provide electricity on a large scale throughout the country and that is closest to being industrialized by the private sector.

Since breeder reactors can utilize a large fraction of uranium, that cannot be used in light water reactors, the reliability of breeders insures nuclear power will be independent for hundreds of years of the factors that could greatly escalate the costs of natural resources. Indeed, from the uranium plant enrichment byproducts that have been processed and stockpiled near Federal fuel enrichment facilities, the breeder can obtain 11,000 quads of energy without additional mining.



FROM THE URANIUM ENRICHMENT PLANT BY-PRODUCTS THAT HAVE ALREADY BEEN PROCESSED AND STOCKPILED, THE BREEDER CAN OBTAIN SOME 11,000 QUADS OF ENERGY WITHOUT FURTHER MINING.

- **MORE THAN 140 TIMES ANNUAL U.S. ENERGY CONSUMPTION**
- **MORE THAN THE ENERGY THAT CAN BE GENERATED FROM KNOWN U.S. DEMONSTRATED COAL RESERVES**
- **SEVERAL TIMES GREATER THAN THE ENERGY EQUIVALENT FROM THE WORLD'S PROVED OIL RESERVES**
- **WORTH MORE THAN $15 TRILLION, BASED ON THE EQUIVALENT COST OF COAL**

Slide 26

Slide 26 puts in perspective what that 11,000 quads of energy is.

Beyond the stockpiled uranium which is reflected in this slide—this is already above ground and known—there is enough remaining in the ground to last for thousands of years in the breeders.

From the outset of the Nation's nuclear program, scientists and policymakers recognized that its ultimate objective should be the development of breeder reactors. Confidence in the technology and the competitive economics of the breeder comes not only from the 30-year U.S. development program but also from the experience of other countries that are developing and operating breeder reactors.

In addition, the breeder technology will have the benefit of an existing infrastructure of industrial expertise which is a natural extension of the existing light water reactor industry.

The timing of the introduction of the breeder in the marketplace is based on considerations of resource producibility, consumption and economics. While these limits are uncertain, in the near term, the capital cost of the breeder is the dominant factor. It is clear from advanced design work in the United States and abroad that breeder plant costs are considerably below what is popularly assumed are feasible.

The possibility of economic breeders by the end of this century is real and offers the possibility of consumer benefits in the next century.

Those who argue for delay in breeder development until final costs and other factors prove its economics beyond a shadow of a doubt would severely penalize future consumers. Experience has shown that decades are required to introduce any new technology. To wait until overwhelming economic advantages have been achieved before initiating introduction of the breeder will result in higher electricity costs.

As is true for most new technologies, gradual introduction under marginal conditions will result in the greatest benefit to the Nation. The breeder development schedule being followed by the Federal Government is based on a prudent planning approach and is aimed at providing the means for the private sector to take principal responsibility for planning, financing, and constructing a large-scale prototype plant before the end of the century.

Commercial, economic breeder technology would be available for private industry to consider as a direct result of this effort allowing them time to phase breeders into general service alongside light water reactors over the following decades. Thus, the time necessary to complete breeder development at our current pace is consistent with the outlook for achieving significant benefits from commercial introduction of breeder reactors.

The goal of the Government's breeder program is to develop the technology to the point that private industry can deliver a safe, economic, commercial breeder power plant; but proving breeder safety and commercial potential will only come through operating experience with complete systems. The Department of Energy breeder program is designed to accomplish this by relying on the over 30 years of breeder research and development, on lessons learned in some 20 years of commercial light water reactor experience, on international cooperation, on information and experience gained from building and operating the Clinch River breeder reactor, and on a strategy of engineering scale-up.

An important step in making breeder technology available is the completion and operation of the Clinch River project. Clinch River will, among other things, demonstrate an important step in the technology required to scale up and successfully construct and operate commercial-sized breeders. It will demonstrate the ability to license a breeder under Nuclear Regulatory Commission regulations and provide operating experience with advanced breeder components and concepts.

Since I last appeared before this committee, the Clinch River project has made considerable progress. NRC permission to conduct site preparation activities was received and site work is well underway. The site suitability and environmental hearings are complete; and the site suitability report and the supplement to the Clinch River final environmental statement containing findings favorable to the project have been issued by the NRC.

We are well ahead of where the project was in 1977 when licensing was terminated. Continued progress in the area of licensing is expected to lead to NRC authorization to begin safety related construction activities in early fiscal year 1984, in calendar year 1983.

The planned activities during fiscal year 1984 include licensing, completion of the site preparation and initiation of construction of the permanent plant structures; in addition, design will be virtually completed during the year and continued progress will be made in fabrication of hardware.

We are mindful of the fact that Clinch River was defeated in the House and narrowly passed in the Senate last Congress. The Conference compromise required the Department of Energy to prepare a report for Congress by March 15 exploring proposals that would reduce Federal budget requirements and secure greater participation from the private sector.

A utility task force of senior financial executives under the chairmanship of Mr. Gordon Corey, formerly the chief financial officer of the Commonwealth Edison Co., has been established to explore additional financing alternatives.

The efforts of this task force are on track and on schedule. We expect to provide a responsive report to the Congress. While no report has yet been drafted by the task force, they are optimistic that a significant reduction in Federal appropriations required to complete the project can be achieved. The Department will, of course, evaluate the task force's proposals and forward them with our own report to the Congress.

As the next step beyond Clinch River, private industry is expected to take the lead and assume principal responsibility for planning, financing and constructing a large-scale prototype to prove breeder economic potential and operations of a full-sized plant.

Thus, DOE has requested the utility industry to take the lead for defining the followup steps for completing this power plant. In addition to conducting independent advanced breeder design efforts, the industry has responded by initiating an activity wherein technical and financial options for the design, development, and eventual construction and operation of a large-scale plant will be evaluated.

Through the utility group, the industry has established a breeder program office that acts as technical integrator for this next plant and is developing the implementation plan for the project.

The objective of this plan is to allow the Government and the utility industry to play their traditional roles. The Government will support the necessary research and development beyond the capability of the industry and the utility industry will finance and operate the plant.

Supporting the breeder plant projects is a base technology program whose mission is to develop the requisite technology to the point where the private sector is able to support construction and operation of safe, reliable, liquid metal breeder reactors for supplying electricity to the grid.

This includes conducting experiments, tests and studies of the technical features and implementation options for power plant projects. During fiscal year 1982 and as part of the process of developing the fiscal year 1983 and fiscal year 1984 budgets, a major effort has been undertaken to focus the base technology program to meet the near-term requirements for industrialization and to forego those "product improvement" efforts that could be left to industry to accomplish during the early commercial development of breeders.

A detailed discussion of the base technology program is, as I mentioned earlier, contained in Dr. Brewer's testimony.

In order to plan for the future and minimize the impact of future energy instabilities, this administration maintains, as the Congress has historically, that the continued development of commercially viable breeder reactor technology is a responsible and prudent action of Government. This task is made all the more important in view of the fact that the Nation's economic health and electricity supply are so closely related and that the consumption of electricity involves annual expenditures in excess of $100 billion.

While the need for breeder technology is clear to us, the benefits, assured fuel supply, international influence, and reduced electricity costs to consumers cannot be captured without a concerted effort by the private sector with help from the Federal Government in areas where present risks are too great for industry to bear alone.

With the growing importance of electric power to our changing economy, and the likely long-term shortage of economic fuels that can be used to generate that power, we are convinced that the next generation of Americans will need a substantial amount of electricity from breeder reactors for their industries, farms, homes and offices.

By continuing with this sound national program, we can assure that the benefits of the breeder will be available when they can do the most for the Nation.

That completes my summary. I will be happy to answer questions or—if you would like—we have a short 5-minute summary status tape on the Clinch River project we would be happy to show if you would like.

[The prepared statement of Gordon L. Chipman follows:]

Statement of Gordon L. Chipman, Jr.
Deputy Assistant Secretary for Breeder Reactor Programs
Department of Energy
Before the
Subcommittee on Energy Research and Production
Committee on Science and Technology
U.S. House of Representatives
February 22, 1983

Madam Chairman and Members of the Committee, I am very pleased to appear before you to present and discuss the Department of Energy's nuclear breeder reactor programs.

Distribution of funds for Breeder Reactor Systems is shown below.

	FY 1983	FY 1984
	(in thousands)	
Breeder Reactor Systems		
Liquid Metal Fast Breeder Reactor	$496,829	$556,825
Water Cooled Breeder	44,984	35,500
Program Direction	8,061	10,200
Total	$549,874	$602,525

Madam Chairman, the Breeder Reactor Systems budget submission contains the accomplishments planned and realized for FY 1983 and those planned for FY 1984. Before discussing the details of our budget request, I would like to address the need for a National breeder program--what the benefits are, what it will take to capture them, and why it is important for the Federal Government to maintain a role in transferring breeder technology to private industry.

The current world oil glut and recent decline in U.S. electric demand have raised questions about the need for a national program to continue development of commercial nuclear breeder reactors for electricity generation. The need for long-term planning and the long gestation periods necessary for developing new, commercially viable technologies require that the breeder program be examined in light of the long-term energy picture, rather than the short-term.

In the decade since the first "oil-shock", nations and industries have funded a number of programs to find and develop both conventional energy resources and new energy technologies. Over that decade, a multitude of scientific studies have attempted to analyze the energy options of this nation and the world. Yet the situation is not much different today than it was 10 years ago. While a slow economy and energy conservation have served to depress growth in energy demand, the underlying long-range facts remain the same: the Nation's most heavily relied upon sources of energy--oil and natural gas--are the most limited in supply; alternative technologies (e.g., synfuels, solar, geothermal, wind, etc.) are either too expensive, too limited, or too immature to have significant National importance in the foreseeable future.

Very little has changed from the international perspective, either. Western Europe and Japan remain heavily dependent on Middle East oil. The International Energy Agency anticipates that even modest economic growth of between 1.7 and 2.6 percent per year could cause demand for oil to outstrip supply as early as 1990. And the situation in the less developed and developing countries continues to be bleak. Moreover, the twin development of industrialization and urbanization in many nations is creating a pressing need for centralized energy systems and dramatically increased oil supplies.

Thus, the need to find large and economical energy supplies remains critical. And, from the broad perspective--one necessary to plan for energy needs 10, 20, and 30 years in the future--electricity plays a key role in maintaining and improving our way of life.

The United States, like other industrialized countries, is steadily becoming more dependent on electricity to sustain economic growth. Even in the conservation-minded 1970's, the demand for electricity increased by 50 percent while the total end-use consumption of other direct forms of energy remained essentially unchanged. Though the past decade has apparently altered the traditional link between overall energy use and economic growth, the link between electricity and the economy has remained generally strong. Correspondingly, the slower growth in electic power demand in recent years--negative last year for the first time in over 30 years--accompanied a slowed national economy.

This relationship has important implications for an improving economy. When economic growth returns to healthy levels--say, 3 to 5 percent a year--the growth in demand for electric power could be at least as high. A 3 percent annual increase in electric power demand would call for a doubling of our National electric power capacity, now about 650 gigawatts, in only 23 years. A 2.3 percent annual increase would require a doubling in around 30 years. Furthermore, 25 percent of the Nation's current steam-electric plants are more than 20 years old now and will become increasingly uneconomic to operate. Thus, replacement plants will be required in addition to the new plants needed to satisfy increased demand.

Future electric growth projections, like economic growth projections, are highly uncertain. However, the reasons for the likely continued long-term importance of electricity can be found in the convenience of electric power to the consumer; in the relatively low price of electric power, the price of which has been increasing more slowly than oil and natural gas prices; and in the evolution away from heavy-industry toward greater reliance on service industries, which are more intrinsically dependent on electricity.

The substitution of electricity for other energy forms can be seen in virtually every segment of our society. More than 50 percent of new homes in the last decade have been heated electrically, as opposed to only 8 percent of all homes before 1970. Because electric arc heating is so much more efficient than combustion heating, electric steelmaking is expected to displace older methods as the Nation's steelmakers strive to increase productivity. Moreover, the increased use of robots and automation by our Nation's industries and information processing by our commercial establishments represents an increased demand for electricity.

The amount of domestic primary energy devoted to electricity production has increased from 9 percent in 1925, to 20 percent in 1960, and to 33 percent today. Many forecasters expect it to increase to 50 percent by the end of the century. Thus, electricity will play an increasingly important role in most energy sectors and especially in the modernization and renewed competitiveness of the Nation's industries. Thus, the Federal government recognizes that adequate supplies of economic electricity are strategically important to the United States both domestically and internationally.

The availability and producibility of primary energy sources are a dominant issue in preparing for the future. Many traditional means for producing electrical energy cannot be counted on to meet this growing need. Remaining sites for large hydropower plants are severely limited. Oil and natural gas, attractive as peaking power options, are generally not regarded as economic fuels for major new baseload electric power stations, and exotic alternatives like synfuels, solar, geothermal, and fusion are either too expensive, too limited, or too immature to have significant national importance in the foreseeable future.

To meet its growing need for large-scale electric power expansion, the United States is left with only two energy sources: coal and nuclear energy. Of course, coal resources are plentiful so scarcity will not limit use. Coal's contribution may be limited, however, by production and transportation capabilities, coupled with environmental concerns.

In contrast, economic uranium resources to fuel conventional light water reactors are more limited than coal. As a result, nuclear power cannot be considered a long-term contributor to our electricity supply without a commercially viable means of significantly extending this resource, a conclusion that points to the importance of the breeder reactor. Nuclear power, with reliance on breeders, is the one advanced technology that could provide electricity on a large scale throughout the country and that is closest to being industrialized by the private sector. Since breeder reactors can utilize the large fraction of uranium that cannot be used in light water reactors, availability of breeders ensures that nuclear power will be independent for hundreds of years of the factors that could greatly escalate the costs of natural resources. Indeed, from the uranium enrichment plant byproducts that have already been processed and stockpiled near Federal fuel enrichment facilities, the breeder can obtain some 11,000 quads of energy without further mining. This is:

- More than 140 times annual U.S. energy consumption;
- More than the energy that can be generated from known U.S. demonstrated coal reserves;
- Several times greater than the energy equivalent from the world's proved oil reserves;
- Worth more than $15 trillion, based on the equivalent cost of coal.

Beyond the stockpiled uranium that is above ground and in known quantity, there is enough remaining in the ground to last for thousands of years.[7] Because the breeder reactor requires only a small annual quantity of uranium (compared to the current generation of light water reactors), its economics are relatively insensitive to uranium price. Thus, it can effectively make use of even low-grade uranium ores if they should be needed in the centuries to come.

When private industry has commercialized the breeder, this energy source will provide a large degree of assurance against future cost increases in electricity. Without the breeder, any difficulties encountered by coal would have a much greater impact on the national economy. The almost exclusive dependence of transportation on oil demonstrates our inherent vulnerability to disruptions by reliance on a single energy source.

From the outset of the nation's nuclear program, scientists and policymakers recognized that its ultimate objective should be the development of breeder reactors. The Federal Government has been conducting a breeder development program for more than 30 years. In fact, the first electricity ever generated by a nuclear powerplant came from the Experimental Breeder Reactor No. 1 in Idaho in 1951.

Confidence in the technology and the competitive economics of the breeder comes not only from the 30-year U.S. development program, but also from the experience of other countries that are developing and operating breeder reactors. In addition, the breeder technology will have the benefit of an existing infrastructure of industrial expertise, which is a natural extension of the existing light-water reactor industry. At the present pace, several decades are needed to achieve significant market penetration and begin to impact electricity prices. This will require completion of the research, development, and demonstration already underway.

The timing of the introduction of the breeder in the marketplace is based on considerations of resource producibility, consumption, and economics. While these elements are uncertain, in the near term the capital cost of breeder reactors is the dominant factor. It is clear from advanced design work in the United States and abroad that breeder plant costs considerably below what is popularly assumed are feasible. The possibility of economic breeders by the end of this century is real and offers the possibility of consumer benefits early in the next century. Those who argue for delay in breeder development until final costs and a other factors prove its economics would severely penalize future consumers. Experience has shown that decades are required to introduce any new technology. To wait until overwhelming economic advantages have been achieved before initiating introduction of the breeder will result in higher electricity costs. As is true for most new technologies, gradual introduction under marginal conditions will result in the greatest benefit to the Nation.

The breeder development schedule being followed by the Federal government is based on a prudent planning approach and is aimed at providing the means for the private sector to take principal responsibility for planning, financing, and constructing a large-scale prototype plant before the end of the century. Commercial economical breeder technology would be available for utilities to consider as a direct result of this effort, allowing them time to phase breeders into general service alongside light water reactors over the following decades. Thus, the time necessary to complete breeder development at our current pace is consistent with the outlook for achieving significant benefits from commercial introduction of breeder reactors.

The goal of the Government's breeder program is to develop the technology to the point that private industry can deliver a safe, economic commercial breeder powerplant. Accordingly, the Government program is focused on developing a competitive and inherently safe breeder. The program has three components: demonstration plant projects, basic research and development, and fuel cycle testing.

Proving breeder safety and commercial potential will only come through operating experience with complete systems. The Department of Energy breeder program is designed to accomplish this by relying on over 30 years of breeder research and development, on lessons learned in 20 years of commercial light water reactor experience, on international cooperation, on information and experience gained from building and operating the Clinch River Breeder Reactor Plant (CRBRP), and on a strategy of engineering scale-up.

An important step in making breeder technology available is the completion and operation of the Clinch River Breeder Reactor Plant. Besides representing a scale-up to 375 Mwe (over twice the size of the Fast Flux Test Facility, a fuel and materials test facility, and about one-third the size of a commercial-size unit), the Clinch River project will offer the following benefits:

- o Demonstrate an important step in the technology required to scale-up and successfully construct and operate commercial-sized breeder reactors, including materials and structures, components, safety features, and control.
- o Provide an important portion of the technical basis for extending the technology to future near-commercial and commercial plants.
- o Demonstrate the ability to license a breeder under Nuclear Regulatory Commission regulations for commercial powerplants.

- Provide operating experience with advanced breeder components and concepts.
- Provide operating experience within a utility environment (on the TVA system).
- Provide a crucial element in international breeder development to maintain U.S. position and influence, and to compete among the world's technological leaders in the international breeder market.

Important actions and accomplishments have been realized by the Clinch River project: (1) receipt of NRC authorization pursuant to 10 CFR 50.12 to conduct site preparation activities; (2) completion of site suitability and environmental hearings; and (3) issuance by NRC of the Site Suitability Report and the Supplement to the CRBRP Final Environmental Statement--both of these documents contain findings favorable to the project. Continued progress in the licensing area is expected to lead to NRC authorization in FY 1983 to begin safety related construction activities in early FY 1984. Planned activities during FY 1984 include licensing activities, completion of site preparation, and initiation of construction of permanent plant structures. Design will be virtually completed during the year and continued progress will be made in the fabrication of hardware.

We are mindful of the fact that the Clinch River project was defeated in the House and narrowly passed the Senate in the last Congress. The conference compromise requires the Department of Energy to prepare a report for Congress by March 15, 1983, exploring proposals that would reduce Federal budget requirements and secure greater participation from the private sector.

A utility task force of senior financial executives, under the chairmanship of Mr. Gordon Corey, former Chief Financial Executive, Commonwealth Edison Company, has been established to explore additional private financing alternatives. A Department of Energy recommendation and task force report will be forwarded to the Congress.

As the next step, private industry is expected to take the lead and assume principal responsibility for planning, financing, and constructing a large-scale prototype to prove breeder economic potential and operation as a full-sized powerplant. Thus, the Department of Energy has requested the utility industry to take the lead for defining the follow-on steps for completing this powerplant. In addition to conducting independent advanced breeder design efforts, the industry has responded by initiating an approximately 2-year Consolidation Phase activity wherein technical and financial options for the design, development, and eventual construction and operation of a Large-Scale Prototype plant will be evaluated. Also, the utility industry has responded by forming a Liquid Metal Fast Breeder Reactor (LMFBR) steering committee. Through the Electric Power Research Institute, the utility industry has established a breeder program office that acts as technical integrator for this next plant and is developing the implementation plan for this project. The objective of this plan is to allow the Government and utility industry to play their traditional roles: the Government will support the necessary research and development beyond the capability of the industry, and the utility industry will finance and operate the plant.

Supporting the breeder plant projects is a base technology program and a fuel testing program. The mission of the base technology program is to develop the requisite technology to the point where the private sector is able to support construction and operation of safe, reliable liquid metal fast breeder reactor plants for supplying electricity to the grid. This includes conducting experiments, tests, and studies of the technical features and implementation options for future plant projects.

The objectives of the fuels program are: to prove a breeder fuel; to extend core life to burnup levels needed for commercial performance; to develop and prove the companion fuel blanket and absorber core component systems; to demonstrate LMFBR core systems that are licenseable; to support CRBRP core requirements to extend core components lifetime to 3 years; to develop, establish and demonstrate an integrated fuel supply for the Fast Flux Test Facility and CRBRP; and to transfer developed technology to industry.

In order to plan for the future and mitigate the negative effects of future energy instabilities, this Administration maintains, as the Congress has historically, that the continued development of commercially viable breeder reactor technology is a responsible and prudent action of government. This task is made all the more important in view of the fact that the Nation's economic health and electricity supply are so closely related, and that the consumption of electricity involves annual expenditures in excess of $100 billion. While the need for breeder technology is clear to us, the benefits--insured fuel supply, international influence, and reduced electricity costs to consumers--cannot be captured without a concerted effort by the private sector with help from the Federal government in areas where present risks are too great for industry to bear alone.

The Federal investment in nuclear power is already paying dividends. Consumers have benefitted from lower prices with nuclear generated electricity and they will continue to benefit as more light water reactors, and eventually breeders, are brought into service. Since 1974, operation of commercial nuclear powerplants has saved consumers an estimated $9 billion through lower priced electricity. These savings grow each year nuclear plants continue to operate. In a study published in 1981 by Pacific Northwest Laboratories,* net economic benefits of the breeder have been estimated at between $37 and $64 billion (in 1980 dollars). While the wide range reflects the large uncertainty in analyses of these kinds (e.g., due to breeder introduction date, uranium fuel producibility and price, and breeder economics relative to coal and light water reactors), the benefits are substantially higher than the estimated Federal investment in breeder reactor technology.

The past year was a significant one for the breeder program and for nuclear power in general--ground breaking at the Clinch River site; formation of a cooperative effort with the private sector to define means for proceeding with future LMFBR plant projects while minimizing risks, taking advantage of foreign cooperation, and providing for private sector funding; restructuring of the breeder program to improve cost effectiveness; and passage of landmark nuclear waste legislation.

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*"Summary: Analysis of Alternative FBR Development Strategies," by J. B. Burnham, December 1981, Pacific Northwest Laboratory (PNL-3600).

As a result of our restructuring, we believe that the breeder program is now largely on track to meeting our goal with a least-cost approach. We believe we can capture the inherent safety advantages and simple systems that are the basis of low cost, reliable operation.

With the growing importance of electric power to our changing economy, and with the likely long-term shortage of economic fuels that can be used to generate that power, we are convinced that the next generation of Americans will need a substantial amount of electricity from breeder reactors for their industries, farms, homes, and offices. By continuing with this sound National program, we can assure that the benefits of the breeder will be available when they can do the most for the Nation. Our entire organization--the Department of Energy, National Laboratories, and contractors--has turned its attention on the simple breeder goal--to provide the means for the private sector to industrialize a safe and commercially viable breeder reactor. Our program will accomplish this through the cohesive efforts of our program elements namely: plant projects, basic research and development, and fuel cycle testing.

Madam Chairman, that completes my prepared remarks. I would be happy to answer any questions you might have.

Mrs. Bouquard. I would certainly like to see the status film. I want to thank you for this excellent testimony. I am sorry more members are not here today. I am going to see that all the members of this committee have the advantage of having a copy of your testimony today.

Please proceed.

Mr. Chipman. Go ahead and play the tape. [A video tape was played.]

Mrs. Bouquard. That is a very good film. I think you have answered most of my questions today. I am looking forward to hearing from you after the report from the Commission is back on March 15.

What can we expect industry to contribute in fiscal year 1984? Is it too early to make a statement in that regard, Gordon, for 1984?

Mr. Chipman. As Dr. Brewer indicated, it is really premature to talk about a magnitude. I think it is fair to say in looking the project over, we have come to a strong conclusion that there is a commercial use to the project. There is a substantial commercial value. It is less than the cost of the project, because this plant was never intended as a commercial venture.

There is a great deal of R&D and first-of-a-kind development costs associated with it. It is this commercial value we are attempting to deal with. The task force is struggling with that, to find ways they can—in fact—raise capital related to the commercial value.

Mrs. Bouquard. What is the status of the approval of the construction permit?

Mr. Chipman. As I indicated earlier, the environmental hearings have been completed.

Mrs. Bouquard. I knew they were done.

Mr. Chipman. We have made a great deal of progress. We are looking forward to the possibility of having the construction permit issued later this year. I would like Mr. Longenecker to speak to that.

Mr. Longenecker. Madam Chairman, we plan to complete the site preparation activities late in this calendar year, in November 1983, and would at that time be prepared and expect to have all the necessary NRC approvals to begin pouring the concrete for the reactor foundation.

Mrs. Bouquard. Thank you very much.

Mr. Valentine, do you have any questions?

Mr. Valentine. Madam Chairman, I do have just one brief question. I do want to say at the outset that I agree with what you say about the necessity to continue with this sort of thing. We are a country, it seems, of peaks and valleys. When the pressure is off, we forget how tight it was when the OPEC nations had their hands around our throats a few years ago.

I come to this place fresh from the boondocks, so to speak. I want to tell you, I tend to favor this sort of thing. I see the need for it. But I want to share with you one of the problems that the Congress—not the Congress so much, but the people who pay the tax bill have with this sort of thing: it is perceived that there is no control over the outflow of Federal dollars. These projects get started, they go on from administration to administration, from bureaucratic leadership to leadership, and it is as if we set the table with Federal dollars and say, "Come, you contractors, you suppliers, be sure to get your share."

Is there any way—anything that you can say to this subcommittee, what is left of it here, as to what kind of controls you or anybody can have over what this thing will cost in the future?

Mr. CHIPMAN. Congressman Valentine, that is clearly one of the major areas of concern in the public's mind and even in the Congress, based particularly on last year's debate. From my perspective, it is an issue that has been blown way out of proportion.

As you know, many of the opponents to the project have seized whatever argument was in vogue at the time. The history of the progression of arguments against the project is an interesting one to look at. The cost one is a difficult one, because unfortunately—particularly the media in the broadest sense of the word—tends to give at least as much credence to the criticism of the cost estimates we have and the controls we have as to our claims of reasonable cost growth.

Two things are important here: the history of this cost growth is primarily one of delay. The costs have increased two-thirds of it due to factors outside the Department's control. Escalation—these are not real dollars, of course, but they do result in increased numbers, and Nuclear Regulatory Commission requirements.

But what about the future? I think that is the essence of your question. If you look at this project, you find a number of things. First of all, it is probably the most heavily investigated and audited project in the history of the Department. It seems to continue in that direction. It is a great burden on the project. In fact, I think sometimes it actually detracts.

There have been many investigations of fraud, abuse, of management control. Is the project being handled properly? The bottom result of all of these generally is, it is well run. We have some of the best contractors in the world involved in this effort.

We have completed, in early 1982, an extensive effort at re-base lining the costs for the project, detailed negotiations have been undertaken. We believe the process that was encountered there was a very valid one.

The bottom line is that we are at a point with this project where the design is nearly complete. Most of the components have been ordered, a large percentage delivered. We are starting site work now.

This is rather unique. Most powerplants, when they start construction, are around 40-percent complete in design. That contributes a great deal to cost escalation. If we can get a schedule that can be maintained without interruption, the costs of this project should be very nearly what we would project today.

I have to admit to you the costs have gone up—I cannot give you an exact figure yet as a result of the recent congressional action. The reduced 1983 budgets and the $270 million requests for 1984 when factored in cause a delay in the optimum schedule which causes an increase in real costs that is very significant, but primarily in inflation.

Barring those kinds of facts, which are primarily under the control of Congress, the project costs should be very stable.

Mr. VALENTINE. I know it is sophisticated business, but the contracts, are they let out to the low bidder, or is it really a cost-plus thing? You say, "Here are the specifications, go build it, send us a bill, make your profits"?

Mr. CHIPMAN. This has been a matter of some controversy. When the project was first started, the design was not well known, and it was considered a research and development project to a large extent. Contracts were entered into that were not low bid type contracts. There was a long detailed negotiation that was entered into with a broad range of contractors. Almost all the nuclear contractors were involved when it was all over with.

This matter was looked into last year and the year before by some other committees; and it is my assessment they found no serious problem with it. But the main thing that has happened is as we moved to the point where the project is really ready to be built, we have, shall we say, re-base lined a lot of these contracts, and we have—for example, on the steam generators, recompeted that contract whereas before it was not recompeted.

As Dr. Brewer said, the cost of building the production units is going to be about one-third of the cost of developing the first prototype. So, we are moving in that direction as much as practical.

Mr. VALENTINE. Thank you very much. Since we are talking about energy, Madam Chairman, somebody has turned the air-conditioning unit on above my head.

Mrs. BOUQUARD. I am beginning to notice that.

Mr. VALENTINE. I suppose when the room is chilled, somebody will turn the heat on to warm it up.

Mrs. BOUQUARD. Thank you very much.

Mr. Walker.

Mr. WALKER. Thank you, Madam Chairman.

You recognize we have a current oil glut in the world in your testimony and also there has recently been a decline in U.S. electrical demand. You designate this to be a short-term condition that we are going to run out of in the near future.

My problem with that is that we get all kinds of predictions before this committee on a number of those things and I think we have to assess it in terms of what we now know.

Would this project be competitive? Would the power generated by any breeder be competitive with $20 a barrel oil?

Mr. CHIPMAN. I think certainly conventional nuclear power and coal would be competitive with $20 a barrel oil.

Breeders, I think, around the turn of the century or before will be. We are not talking about immediate, today, competitiveness. The point about electricity is a key one here.

I realize the Congress constantly gets various growth projections before it. One of the things that concerns me is that we don't want to repeat the fallacies of the past. In 1970, we were projecting 1,000 nuclear powerplants by the year 2000.

That was based on something like 30 years of trends. Of course, we couldn't predict OPEC. A few people did, but everyone made the same mistake.

Now people are looking around and based upon about 2 or 3 years of low or negative growth in electricity, they are trying to say that is what we should project 20, 30, 40, 50 years into the future.

I think that is greater hypocrisy than the original one. What we should do is look at the electricity growth situation in relation to the GNP.

What we find is they follow one another. So the facts suggest that electricity demand is closely tied to GNP. If we want to project a bad economy for 10, 20, 30, 40, 50 years into the future, then we can say the technical data today suggests we don't need to worry about more generating capacity of any kind.

If we want to say that we should plan on at least a moderately healthy economy in the long term, that says electricity will grow on the basis of everything that happened before and during and now in relation to the oil crisis.

Mr. **Walker**. I don't disagree with that. I think that is absolutely right. But I think the other thing we have probably learned over the last 20 years or so as we have looked at the problems is that the mistake this country has consistently made in terms of its energy decisions is that we have consistently aimed all of our attention in one particular energy direction, and whether it be coal or oil or nuclear or whatever it was, we have tended to say this is the solution.

It has become a one-track kind of solution we have got. In large part that is the problem I now come up with when I look at the breeder for a varity of reasons.

We are finding ourselves with a declining number of energy reserve dollars available to us. We are talking here about a project that absorbs somewhere in the vicinity of 20 to 35 percent of all the energy research dollars that we have, one project.

If you are absolutely right about the fact that we have to predict long-term growth in the economy which will bring about long-term growth in the energy market, then it seems to me Congress is far better off wedding itself to a policy that produces a variety of options for energy, particularly a variety of options for electricity, rather than devoting ourselves almost exclusively to one, and what I would like is your assessment, given what you just told me, how we can justify 30 percent of all the money that we are spending for research going in the one direction only.

Mr. **Chipman**. You certainly are correct in noting we have a continually decreasing dollar amount that is available for energy R&D. Your question is a good one. I think in many people's minds it is a central one and results in many people attacking nuclear power and the breeder for that reason only, when they have no other reason to do so.

This is a very emotional issue. I will try to give you my perspective on it. I don't want to step on any toes here, but let's look at some of the alternatives to the breeder reactor for the long-term future.

I think it is clear many of them are very limited in scope. I take geothermal, for example, I think it has a potential, but we can't talk about geothermal solving our long-term electricity supply needs.

We can't because of its limited geographical applicability. There are other technologies that fit the same consideration, and the groups like the National Academy of Sciences that generally are not considered to be biased or trying to push for social change or being in favor of one type of energy over another have concluded that these alternatives—including solar, biomass, hydro or geothermal energy simply are not in a position that they can meet the needs of the next several decades.

It is not that they shouldn't be pursued. It is not that they can't make a contribution, but they really cannot meet those needs.

It will have to be coal and nuclear power that will do the job. We have a limited budget. Two things have to be asked. What are you going to do with that money? Will it be spread so thin no technology is available to meet our needs?

Many of the other technologies—and I take solar as an example—are well into the market place already. There are close to a thousand companies marketing solar technology. There is continued Federal funding of a very limited amount of solar technology which the private sector is also putting a great deal of money in.

That is in the photovoltaic area. Private industry is moving out rapidly in that area to the extent the market place will carry it. If you live where I live, they built a solar breeder reactor on private funds using taxbreaks and other things.

It is extremely uneconomic at this time, but the industry believes they can carry the ball.

Should we continue to dilute our funds across-the-board without regard to what industry can and can't do, or should we focus it where we know the industry can't deal with the problem?

I believe that is why the administration is focusing such a great portion of its funds on the breeder reactor.

I just would add one further thought. The administration has made it very clear that it will not continue with the breeder with high Federal funding. We want to complete the Clinch River project at reduced requirements with increased private contributions.

We have a base technology program which will be winding down. The next project will be built by the private sector.

Mr. **Walker**. Again, I don't wholly disagree with what you say, but I think that you also put your finger on the problem that I have got in terms of the magnitude of the funding. I am not antinuclear. I don't come at it from the standpoint of comparing nuclear with the solar or geothermal or some of the more exotic alternative energies.

I happen to think that we ought to try to give them whatever help we can to help them become marketable but we ought to then spin them off in the marketplace and let them compete with $20 a barrel oil, too.

On the other hand, it seems to me we also have the obligation to do what we can to make coal, more efficient technology, if that will have to be one of our items for dependence in the future.

We have an obligation to make nuclear a more efficient kind of process. How much of our ability to do some of those kinds of things are we stripping out when we devote 30 percent of the budget in one direction?

Those are my problems. I think we are, in fact, reducing energy options, known energy options, as we take such a large percentage of the funding.

My question stems really from that. It also stems from the fact that you have got an industry right now that hasn't shown itself very capable of responding to the problems within it.

Their response to Three Mile Island, which is near and dear to me, has been totally inadequate. They have run around making all kinds of statements that there will be help coming to the Three Mile Island.

When it comes down to it, they want the Government to push them into it. That has been almost impossible to achieve.

So when they do come up against the kinds of problems that should be addressed for the future viability of the industry, they found themselves incapable of doing it. To go to one more major technology, one more new issue, or one more new technology that they also may be incapable of addressing, seems to me to be a highly questionable use of funding.

Mr. CHIPMAN. As you know, the utility industry is in pretty bad shape financially. They are not building coal plants. They are not building nuclear plants. They are not really building anything.

Mr. WALKER. Now you come in and say you want a contribution for the breeder to sap away those fundings or at least some of the future of the breeder is based upon the idea that industry is going to come in with a contribution for it.

What I am saying is from my perspective, they have problems they better be solving that go beyond that.

If I have to get parochial about it, I would rather see that money heading toward Three Mile Island to solve the problem they have sitting up there that needs to be addressed right now.

Mr. CHIPMAN. Clearly there is a problem there. My point about the utility industry is simply they are not in a position to begin building anything right now. It is clear to say the utility industry will take care of the problem. They are not even a private industry.

It is a highly regulated monopoly.

Mr. WALKER. Particularly he can't build anything so long as they have trouble justifying the cost of the power produced to a public utility commission. Clearly both in terms of coal and nuclear, they are having a great deal of difficulty doing that.

That seems to me to demand that the research dollars that we utilize go toward improving the efficiency of those kinds of plants so they can begin to sell those to public utility commissions again.

If we are going to have a greater demand for electricity in the future, we better be prepared to make certain what the utility industry brings online can be justified to the people that they have got to take it to, namely, the public utility commissions who have to approve at some point a rate schedule.

They can't do that in the nuclear industry right now. They can't do it even with coal plants at the present time.

I think the one place where the $20 a barrel oil begins to frustrate that is it makes it more difficult to justify those projects, unless we provide through research some direction as to how those plants can be made more efficient.

I think we are sapping away our ability to do that as we direct all too much funding in one particular direction.

Mr. CHIPMAN. Mr. Walker, I would just suggest I don't think the problems that utilities have in planning for the future is because of low efficiency in coal or nuclear powerplants.

I think it is just a general economic, financial, and attitude situation of the consumer related to electric power. But if we need to plan for the future, and if you want the Federal Government to play the primary role in that, then we either need more money or we are not going to be able to complete the programs that hold the greatest benefit for the future such as the breeder reactor.

We can talk about increasing the efficiency of light water reactors 15 or 20 percent. I am talking about a technology that is 6,000 to 10,000 percent. It is here. We know what to do. We can do it.

Mr. WALKER. We can always say we need more money. I guess what I am arguing is at least we ought to make the most efficient use of the money we have got.

Every time we come up against these things, everybody can come up with a solution we can put more money in. I could name you a hundred areas we could spend more money out of this committee.

We have had excellent testimony over the years of all kinds of things that would be very valuable to do research on. The fact is we don't have the money.

I guess my argument is let's make certain we get the broadest possible clout for the money we do have to spend. That is where I come up against the problem of spending 30, 35 percent of our money for one project alone.

Mr. CHIPMAN. I understand your problem. I would suggest this.

If we dilute the breeder effort significantly, we won't have it either. Then your objective, my objective will be defeated.

We have a technology here that must have Federal support in the near term because of many of the reasons we have talked about. We know it will work. We know it will meet the needs of the future.

Putting this money in will guarantee its availability. The other technologies have severe limitations. They are also in the market place to a great extent, and I would simply suggest that to dilute this effort will, in the end, cost the consumer money.

But this is a debate we can probably never solve.

Mr. WALKER. Thank you, Madam Chairman.

Mrs. BOUQUARD. Thank you very much.

I would like to ask unanimous consent to allow members of the subcommittee to submit questions in writing because there are so many members not present today.

We will meet again in the morning at 9:30 in this room 2325 to hear from nongovernment witnesses on the breeder reactor program.

Thank you, gentlemen, for being with us today and for your valuable testimony.

We stand adjourned.

[Whereupon, at 11:45 a.m., the subcommittee was recessed, to reconvene at 9:30 a.m., Wednesday, February 23, 1983.]

1984 DEPARTMENT OF ENERGY AUTHORIZATION

WEDNESDAY, FEBRUARY 23, 1983

House of Representatives,
Committee on Science and Technology,
Subcommittee on Energy Research and Production,
Washington, D.C.

The subcommittee met, pursuant to notice, at 9:35 a.m., in room 2325, Rayburn House Office Building, Hon. Marilyn Lloyd Bouquard (chairman of the subcommittee) presiding.

Present: Representatives Bouquard, Lundine, Walker, Chandler, and Lowery.

Staff present: John V. Dugan, staff director; Nelson L. Milder, technical consultant; Louis Ventre, counsel; David Clement, minority counsel; and William T. Harvey, minority energy coordinator.

Mrs. **Bouquard**. The hearing will come to order.

Good morning.

My suggestion to the subcommittee this morning and to the Congress in this session is to take a good look at the overall breeder reactor program. It has a fresh focus on economics and a renewed emphasis on safety in this fiscal year 1984 budget request.

After considerable urging, the Department has recognized the need to insist on improving the economics of breeder plants decades from now when this technology would be commercially deployed. I am very pleased at the focus on low-cost designs which rejects the shopworn premise that the breeders must have higher capital costs than light water plants.

I am also pleased to see that the Department is emphasizing the attractive safety features of the breeder plants which virtually put them in the "walk-away" reactor category.

It is also worth noting that the timing of the present program and projected dates for achieving economic plants make breeder deployment independent of uranium supply arguments.

I intend to see that the Department implements their program plans and allows industry to play their proper role since they must ultimately build and operate the plant.

The Clinch River breeder reactor issue will also have a new look this year since we expect to hear from the DOE on possible methods of alternative financing. I am pleased to see the impressive amount of innovative thinking that is taking place on this question.

I also believe that we must look for an enhanced level of international cooperation in the breeder reactor program because of the limited resources available in terms of capable people and budget dollars. I intend to pursue this avenue of cooperative venture with the United Kingdom and Japan during this Congress. I think we should all recognize that this country must operate demonstration and prototype plants in order to commercially deploy this technology. Our need to retain international preeminence. as well as the significant barriers to regulatory licensing of foreign nuclear technologies, make such experience mandatory.

This morning we are going to hear a variety of views on the breeder program. They range from those of long-time utility and industrial supporters of the Clinch River project through an eminent scientist's perspective as well as certain opponents of the project. I think it will be educational for all of us to hear these views.

At this time the opening remarks of the ranking Republican, Mr. Walker, will be made part of the hearing record.

[The opening statement of Robert S. Walker follows:]

OPENING REMARKS OF REPRESENTATIVE ROBERT S. WALKER
FEBRUARY 23, 1983

THANK YOU MADAME CHAIRMAN, AND I WOULD LIKE TO JOIN YOU IN WELCOMING OUR WITNESSES HERE TODAY. WE ARE LOOKING FORWARD TO HEARING THEIR VIEWS ON THE DEPARTMENT OF ENERGY PROGRAMS FOR THE COMING FISCAL YEAR.

I THINK THAT IT IS IMPORTANT THAT WE GET THE INDUSTRY VIEW FOR SEVERAL REASONS. THE FIRST IS THAT EVERY GOVERNMENT PROGRAM NEEDS TO BE VIEWED BY OUTSIDE OBSERVERS WHO CAN DISCUSS THE VARIOUS STRENGTHS AND WEAKNESSES IN AN OBJECTIVE MANNER. WHILE INDUSTRY IS NOT ALWAYS ENTIRELY OBJECTIVE, THEY DO BRING AN IMPORTANT VIEWPOINT TO OUR DELIBERATIONS.

BUT I AM ALSO GLAD TO SEE REPRESENTATIVES OF THE INDUSTRY BEFORE US TODAY FOR ANOTHER, AND FAR MORE IMPORTANT REASON. IT IS MY BELIEF THAT, AT LEAST SO FAR, INDUSTRY HAS NOT BEEN PARTICULARLY RESPONSIVE TO THE CONTINUING PROBLEMS AT THE CRIPPLED THREE MILE ISLAND REACTOR.

IN MY DISCUSSIONS WITH PEOPLE FROM THE INDUSTRY AND FROM OTHER NATIONS I HAVE HEARD REPEATEDLY THAT THEY WILL BE ABLE TO MAKE GREAT USE OF THE INFORMATION WHICH IS BEING GENERATED BY THE CLEAN-UP ACTIVITIES AT TMI. THAT DATA WILL BE USED TO ENGINEER MAJOR IMPROVEMENTS IN DESIGN AND CONSTRUCTION OF A BROAD RANGE OF REACTOR COMPONENTS AND SYSTEMS RANGING FROM BASIC DESIGN THROUGH CONTROL CONFIGURATION AND OPERATIONAL CONTROLS AND TRAINING.

BUT, DESPITE THE FACT THAT THERE SEEMS TO BE A UNIVERSAL AGREEMENT THAT ALL OF THIS DATA WILL BE OF INCALCUABLE VALUE TO THE INDUSTRY, IT SEEMS THAT THERE IS A UNIVERSAL RELUCTANCE TO HELP SHARE THE COSTS OF GATHERING THE DATA AND CONTINUING THE CLEAN-UP.

TODAY WE WILL BE DISCUSSING THE FEDERAL RESEARCH AND DEVELOPMENT PROGRAM. IT IS FITTING THAT THE GOVERNMENT SHOULD BE INVOLVED IN RESEARCH, DEVELOPMENT AND DEMONSTRATION OF NEW TECHNOLOGIES WHICH WILL AID ALL OF THE PEOPLE IN THE LONG RUN. BUT IT IS ALSO FITTING THAT THE MEMBERS OF THE INDUSTRY UNDERSTAND AND ACCEPT THAT JUST BECAUSE THEY WERE FORTUNATE ENOUGH TO AVOID THE TRAGEDY AT TMI, THEY STILL HAVE A ROLE TO PLAY IN THE CLEAN-UP. TO PARAPHRASE AN OLD SAYING, GENTLEMEN, IF YOU DO NOT ALL HANG TOGETHER, THEN YOU SHALL SURELY ALL HANG SEPERATELY.

Mrs. **BOUQUARD**. Do you have any comments?

We have a distinguished panel to bring to our hearing this morning. I do not think our table will really accommodate our panel this morning.

We are very happy to see all of you this morning.

Dr. John Yasinsky is the general manager of the Advanced Power Systems Division, Westinghouse Electric Corp.

Mr. John Taylor is the director of the Nuclear Power Division, Electric Power Research Institute.

Dr. R. B. Richards is general manager of the Advanced Reactor Systems Department of the General Electric Co.

Mr. John J. Kearney, Sr., is vice president of the energy and environmental activities, Edison Electric Institute.

Mr. Morgan Dubrow is with us, I believe.

Mr. **DUBROW**. Yes; I am here.

Mrs. **BOUQUARD**. There he is. I think he has Mr. Partridge's name in front of him there.

Mr. Dubrow is senior staff engineer of the National Rural Electric Cooperative Association.

Gentlemen, you may proceed as you wish. We do have, I believe, all of your prepared statements. Your entire statements will be part of the record following your oral presentations. You may proceed to summarize or present your testimony as you wish at this time.

Thank you so much for being with us this morning. We will certainly hear from you now.

However you want to proceed is fine with me.

STATEMENT OF JOHN J. KEARNEY, SR., VICE PRESIDENT, ENERGY AND ENVIRONMENTAL ACTIVITIES, EDISON ELECTRIC INSTITUTE, WASHINGTON, D.C.

Mr. Kearney. Madam Chairman, if it is all right with you, I was selected to start off; I lost.

Mrs. Bouquard. Fine.

Mr. Kearney. My name is John J. Kearney. I am a senior vice president of the Edison Electric Institute, which is the national association of electric power companies. Our members provide 78 percent of the Nation's electricity and serve over 67 million customers.

We appreciate the opportunity to appear before you on this very important subject of fast breeder technology. I appreciate the opportunity of having our statement incorporated in the record. What I will do is summarize an already very short statement.

I would like to point out just a few things. No. 1, we think that one of the primary goals of our Nation's energy supply system should be the early replacement of our demands of the depleting reserves of petroleum wherever practical and use our domestic resources—coal and nuclear. In order to truly make our uranium supplies a long-term energy resource, we believe that the breeder must be developed. It is for that reason that we have in the past and today support the Nation's breeder reactor program, which is based on the liquid metal fast breeder technology as the preferred technology.

I also would like to point out that electric utilities are converters of energy, and, therefore, we have no vested interest in any particular fuel resource or any particular conversion process. Our objective is to provide electricity at the lowest practical cost on a dependable and reliable basis and in a safe and environmentally acceptable fashion.

With that objective in mind, at this stage, the conservative, high-confidence path necessary for longer term electric utility operations requires the development of the LMFBR technology in a timely manner. In short, if nuclear power is to be a long-term energy option, the breeder must be developed. We further believe that building on research and development over the past 25 years we are at a stage where a demonstration facility should be built and operated as soon as possible. We believe that the Clinch River breeder reactor is that demonstration plant; that it is the right size to have a prudent exploration of the FFTF technology on the path of high confidence; that the design is based on many years of research and development; that it has continually been upgraded to reflect current technology and the most recent safety standards for all nuclear plants.

While the United States may trail other countries in demonstration breeder reactor operations, the Clinch River design incorporates features and innovations that no other nation can claim.

Madam Chairman, this concludes the summary of my statement, and I now suggest that we might hear from Morgan Dubrow.

[The prepared statement of John J. Kearney, Sr., to be supplied, follows:]

STATEMENT OF

JOHN J. KEARNEY
SENIOR VICE PRESIDENT
EDISON ELECTRIC INSTITUTE

ON

FISCAL YEAR 1984 DEPARTMENT OF ENERGY BUDGET REQUEST
FOR THE
BREEDER REACTOR PROGRAM

BEFORE THE

SUBCOMMITTEE ON ENERGY RESEARCH AND PRODUCTION
COMMITTEE ON SCIENCE AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES

FEBRUARY 23, 1983

Madam Chairman and Subcommittee Members, my name is John J. Kearney, and I am a Senior Vice President of the Edison Electric Institute. The Institute is the association of investor-owned electric utilities. Its members provide about 78 percent of the nation's electricity, serving over 67 million customers.

I am pleased to appear before you today to present the Institute's views on the Fiscal Year 1984 Civilian Nuclear Budget as it pertains to breeder reactors. We appreciate your initiative to maintain a continuing dialogue with the electric utility industry regarding this important issue.

Madam Chairman, a primary goal of the nation's energy future should be the early replacement of our demand on the depleting world reserve of petroleum, wherever practical, with the long-term use of our most abundant domestic fuels -- coal and uranium. But, if uranium is to be a truly long-term energy resource, we are firmly convinced that breeder reactors must be developed. Therefore, our industry continues, as documented by the many times we have had the privilege to appear before your Committee, to support this nation's breeder reactor program, which is based on the Liquid Metal Fast Breeder Reactor (LMFBR) as the preferred technology.

Electric utilities are energy converters and, therefore, do not have a vested interest in a particular fuel resource or conversion process. This objective is to provide electricity at the lowest practical cost on a dependable and reliable basis, and in a safe and environmentally acceptable fashion. With this objective in mind, at this stage, the conservative, high-confidence path necessary for longer-term electric utility industry operations requires the development of the LMFBR technology in a timely manner. In short, if nuclear power is to be a long-term energy option, breeders, because of their ability to significantly extend the productive life of natural uranium, must succeed conventional light-water reactors as the primary source of nuclear-generated electricity.

We fully recognize that the LMFBR technology entails major challenges that require massive efforts both in manpower resources and in developmental funding. Building upon the research and development efforts of the past 25 years, we are definitely at the point where a demonstration facility should be built and operated as soon as possible. Other steps will be required to provide the basic knowledge and confidence that is necessary for the electric utility industry to accept the LMFBR as a dependable power system. This program entails several more decades of effort. The timeframe, however, does allow the U.S. to develop an indigenous breeder reactor capability if it is pursued expeditiously.

Major research and development programs must be continued to minimize the overall risks associated with the application of breeder reactors. The fruits of the research of the past 25 years, however, should be applied and evaluated in a specific demonstration facility to identify those areas where weaknesses point out the need for more concentrated research. The Fast Flux Test Facility (FFTF) is the primary facility for basic material and fuel research. The next prudent and reasonable step is the construction and operation of an appropriate size demonstration facility.

The 375-MWe Clinch River Breeder Reactor (CRBR) is the right size to achieve a prudent extrapolation from the FFTF technology on a path of high confidence. The Clinch River design is based on many years of research and development experience. It has continually been upgraded to reflect current technology and the most recent safety standards for all nuclear plants. While the U.S. trails other countries in demonstration breeder plant operation, the Clinch River design incorporates features and innovations no other nation can claim.

Any alternative demonstration plant would have an overall higher cost and would not be available within the time-frame that is achievable with the CRBR. Clinch River should be constructed on an expeditious schedule to minimize unnecessary future delay costs. Its completion is the next and currently most important step in assuring that our country has access to the LMFBR on a timely basis.

The overall LMFBR program also must include the development of the breeder reactor fuel cycle which includes reprocessing, fuel fabrication and the development of systems to resist diversion of fissionable material.

This concludes my prepared statement, Madam Chairman. I would be pleased to answer any questions.

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BIOGRAPHY OF

JOHN J. KEARNEY
SENIOR VICE PRESIDENT
ENERGY AND ENVIRONMENT GROUP

EDISON ELECTRIC INSTITUTE

John J. Kearney was elected a Senior Vice President of the Edison Electric Institute, the principal national association of America's investor-owned electric utility industry, in January 1975. Prior to that time he served in the capacity of Vice President since January 1971. Currently, he is responsible for the Energy and Environment Group of the Institute. The Group consists of the Institute's Nuclear Activities Department, Fossil Fuels Department, Environmental Activities Department, Standards Department and the Engineering and Systems Operations Division.

Prior to joining EEI in 1960, Mr. Kearney was on the editorial staff of Electrical World Magazine published by the McGraw-Hill Publishing Company for the six-year period 1954 to 1960. At the time of his resignation from the Magazine, Mr. Kearney was Managing Technical Editor with responsibility for the selection and processing of all technical material which was published. Upon graduating from college in 1948, he was employed by Ebasco Services, Inc., a New York architect-engineering firm, as an electrical design engineer. He participated in the design, construction and start-up of several thermal electric power plants.

Mr. Kearney is a graduate of the University of Notre Dame with Bachelor of Science degrees in Mathematics (1945) and Electrical Engineering (1948). While studying for his second degree, he was employed by the University as a Graduate Instructor in Mathematics.

October 1982

Mrs. **Bouquard**. Mr. Dubrow.

STATEMENT OF MORGAN DUBROW, SENIOR STAFF ENGINEER, NATIONAL RURAL ELECTRIC COOPERATIVE ASSOCIATION

Mr. **Dubrow**. I am delighted to be here.

Mrs. **Bouquard**. We are happy to have you with us, too.

Mr. **Dubrow**. I apologize because Mr. Partridge had hoped to be here this morning, but he had to leave town. I am delighted to be here in his place and to have an opportunity to reaffirm our support for this vital program.

As you know, Madam Chairman, we have over a 1,000 rural electric cooperatives that serve some 25 million people in 46 States.

Mrs. **Bouquard**. You do a good job, too. We appreciate it.

Mr. **Dubrow**. Thank you very much.

It gives me a lot of pleasure to be here to assist the utility industry in its support for this project and to seek support from the Congress.

I would like to read a paragraph that Mr. Alex Radin asked me to insert in my statement. Mr. Radin is executive director of the American Public Power Association. I will just read it.

It says:

> We conferred with Mr. Alex Radin, the executive director of the American Public Power Association. Mr. Radin asked us to advise the subcommittee that, based on a careful review of the pros and cons of the Clinch River project, on February 9, 1983, his board of directors unanimously reaffirmed its support for the continued construction and completion of the Clinch River breeder reactor project.

With the support from EEI, APPA, and from us, I am happy to say that the utility industry unanimously supports this project.

The reason that we support the project is simply, as Mr. Kearney stated, we know that we are going to have to have additional supplies of electricity, and we feel that for the nuclear program to be viable and to do the kind of job that we hope it will do, and must do, for this country, we must go forward with our own liquid metal fast breeder reactor project.

We have some 432 cooperatives that participated in the original contracts with the Project Management Corp. Mr. Partridge serves on the board.

I will just conclude by telling you that at our 41st annual meeting in Las Vegas, I have attached to my statement two resolutions which were unanimously reaffirmed by our whole membership in support of this vital program.

We appreciate the opportunity to present our views.

Mrs. **Bouquard**. Thank you very much.

[The prepared statement of Robert D. Partridge follows:]

STATEMENT BY ROBERT D. PARTRIDGE, EXECUTIVE VICE PRESIDENT, NATIONAL RURAL ELECTRIC COOPERATIVE ASSOCIATION

Mr. Chairman and members of the Subcommittee, my name is Robert D. Partridge. I am Executive Vice President of the National Rural Electric Cooperative Association, the national service organization for rural electric systems.

As you know, most of rural America receives its electricity from the thousand consumer-owned rural electric systems participating in the rural electrification program. These utilities, mostly cooperatives, serve about 25 million people in 46 states.

During the 47 years of the REA program through 1982, the rural electric systems have built $34 billion worth of electric utility plants. The have paid over $7 billion of principal and interest on loans and are ahead of schedule by more than $54,000,000.

I appreciate the opportunity to express our views to the Subcommittee on the country's Breeder Reactor Program. We join with the other panelists in urging the Subcommittee to continue to support the Clinch River Breeder Reactor Project. We conferred with Mr. Alex Radin, Executive Director of the American Public Power Association. Mr. Radin asked us to advise the Subcommittee that based on a careful review of the pros and cons of CRBRP, on February 9, 1983, APPA's Board of Directors unanimously reaffirmed its support for the continued construction and completion of the Clinch River Breeder Reactor Project.

Despite the fact that some rural cooperatives experienced little or no load growth last year, overall cooperative loads increased by about 2 percent. I am certain that out nation's need for electricity will expand as our population grows and our economy recovers. The Utility industry must continue to provide the safest, cleanest, and most economical energy to the nation both now and in the future—and to provide it in amounts sufficient to support our country's needs. This is a full-time job, involving a close working knowledge of economics, evolving regulatory requirements, availability of resources, and future energy needs. And, in this capital-intensive environment, it also requires hard choices about where to direct our efforts for maximum gain. In making these choices, we must continue to look beyond our short-term economic needs and look toward a secure energy future. America cannot afford to foreclose essential energy options. We must continue to recognize the limitations of all our currently viable energy resources. Therefore, we must secure the means to replace or indefinitely extend these resources.

As you know, breeder reactors increase the efficiency of uranium utilization by a factor of 60; hence they are essential to the energy mix that will enable the United States to meet long-term energy needs. Its advanced design, sound management and high level of accomplishment to mind makes the Clinch River Project a necessary part of the ongoing U.S. program to advance the breeder to the point of commercial deployment. The project must be continued to preserve the confidence of the taxpayers, utilities, private industries, and research institutions that have contributed to its success. The Clinch River Project is an essential advance in our technology which must precede commercial development of breeders by the United States. The utility industry supports this effort to achieve energy independence. We meed Congress' continued support in going forward with the development of nuclear power and the construction of nuclear power facilities. Passage of the Waste Management legislation was a fine example of that support.

The National Rural Electric Cooperative Association (NRECA) has been a strong supporter of nuclear power production since the inception of the program by President Eisenhower in the early 1950's. The Elk River Plant, which was started in 1956 and completed in 1960 by the United Power Association, was one of the early efforts to produce electricity at small nuclear power facilities. The LaCrosse Nuclear Generating Station of the Dairyland Power Cooperative began commercial operation in 1969 and is continuning to help serve our consumeres in Wisconsin. At the present time there are at least 20 generation and transmission cooperatives which are engaged in joint ventures for the production of nuclear power in 16 states. Our cooperatives own at the present time over 3400 megawatts of nuclear power in joint ventures and are committed to repay in excess of $8.8 billion for this power supply.

In order to achieve the long-term benefits of nuclear power, our Association has supported the development of the Clinch River Liquid Metal Fast Breeder Reactor since its inception. In fact, some 432 of our cooperatives are participants in the contractual arrangements between the U.S. Government and the utility industry for the design, construction and operation of this power facility. We remain firmly convinced that completion of Clinch River is a necessary step in the commercialization of the breeder program. Taking the long view, it is the assured means of serving electircity needs of our country along with the use of coal. Continuing to build the Clinch River Project is the thing to do right now.

Our Association also supports the continued development of the High Temperature Gas-Cooled Reactor (HTGR). This nuclear facility has a potential for greater operating efficiency and greater flexibility in locating the power plant and has a potential for providing industrial heat requirements. NRECA urges the subcommittee to continue the support of gas-cooled reactors.

We are pleased that the Federal Government can now provide for storage of nuclear fuel; this will make possible processing of residual fissionable uranium and newly generated fissionable material which (through revcovery and recycling) can generate substantially more energy from the same fuel. Energy from this source is estimated to be the equivalent of over one-half of the nation's proven oil reserves.

We appreciate the assistance of the Congress in going forward with this program for development and commercialization of the breeder reactor, thereby insuring this valuable resource for an independent energy future for America in the twenty-first century.

On February 3, 1983, at NRECA's 41st annual meeting in Las Vegas, Nevada, our membership adopted unanimously two resolutions (copies attached) in support of a revitalized nuclear power program. Some important features of these resolutions are:

1. The Federal Government should set policy, and both the Administration and the Congress provide leadership and support for an aggressive nuclear program.
2. Congress is urged to continue its support of the LMFBR and the gas-cooled reactor programs, and to promptly construct the Clinch River Liquid Metal Fast Breeder Reactor.
3. Congress should authorize and implement a program which recycles spent nuclear fuel and stored potential nuclear fuel to take advantage of present reprocessing technology, thus utilizing these valuable energy resources.
4. Congress and the Administration should help the utility industry allay the fears of the American people regarding radiation exposure and physical destruction of property from nuclear plant accidents by stressing the work of the Institute of Nuclear Power Operations (INPO) whose functions are to insure excellence in the safe design, construction and operation of nuclear power plants.
5. Congress and the Administration should simplify and shorten the nuclear licensing procedures and encourage the issuance of needed limited work authorizations, construction permits and operating licenses on a timely basis.

It seems ironic that in an age when technological advancement is so vital to the future of this nation that we are debating the efficacy of competing with other world powers in the development of high techonology in the energy field.

But that is one of the key issues in the question of whether or not we are going to proceed with completing of the Clinch River Breeder Reactor. Aside from the point of energy independence and providing abundant energy sources for the future, we must face the issue of whether or not we are going to pull back from the investment that we began more than 10 years ago in developing nuclear power resources and let other nations leave us behind, or are we going to maintain leadership in this crucial field of industry and commerce.

The Clinch River Breeder Reactor Project is planned to demonstrate the liquid metal fast breeder reactor process. And France, Great Britain and the Soviet Union have built and been operating LMFBR demonstration plants since the 1970s. West Germany is now building an intermediate size demonstration plant and Japan has one on the drawing board.

It seems wasteful and foolhardy to me for the United States at this juncture to take the position, in effect, that further investment in the development of the breeder concept is unwise. After all, it is not as if we were just beginning. Let's also look at the energy side of the issue. We cannot turn our backs on the 250,000 tons of uranium tailings in stockpile—the energy equivalent of all U.S. Coal reserves, or more than all the oil reserves of the OPEC nations. Plant design is more than 86 percent complete. Research and development is 96.5 percent finished. Around $700 million worth of equipment has already been purchased or is on order.

The Clinch River Project is an essential advance in our technology which must precede commercial development of breeders by the United States. The utility industry believes this effort is necessary to the goal of energy independence.

We appreciate the opportunity to submit our Association's views. Mr. Speaker,

GOVERNMENT SUPPORT FOR A REVITALIZED NUCLEAR PROGRAM

The availability of adequate amounts of power and energy is vital to the future growth and security of our nation as a leader of the Free World. As a direct result of uncertainty, indecision and deliberate delay on the part of the federal government, our nation faces the long-term prospect of energy shortages, declining productivity, inflation and increasing inability to compete in the international marketplace, resulting in growing unemployment and potential civil unrest.

Any honest and realistic examination of the power outlook in America today clearly indicates that if the nation is to deal effectively with these growing energy-related problems, nuclear power must play a significant role for the foreseeable future.

Because of the decline in the planning, construction and the cancellation of nuclear power plants, this country will necessarily have to place an ever growing reliance on coal—a nonrenewable resource—as its primary source of fuel for the generation of electricity.

We feel that such a trend is contrary to our nation's best interest and a balanced program unsing new coal and nuclear plants would be far more economical and both environmentally and politically acceptable.

We, therefore, recommend that the federal government set policy, and both the Administration and the Congress provide leadership and support for an aggressive nuclear program. It is of vital importance that positive action be given to:

1. Allay the fears of the American people regarding radiation exposure and physical destruction of propety from nuclear plant accidents by stressing the work of the Institute of Nuclear Power Operations (INPO) whose functions are to insure excellence in the safe design, construction and operation of nuclear power plants.
2. Encourage the nuclear industry to plan and construct nuclear power plants.
3. Simplify and shorten the nuclear licensing procedures, encouraging the issuance of needed limited work authorizations, construction permits and operating licenses on a timely basis.

THE BREEDER REACTOR AND NUCLEAR ENERGY RESEARCH

We are deeply concerned by any de-emphasis of nuclear power as a viable power option for the future and the resulting neglect of research and development involving nuclear power in general and the breeder reactor in particular.

There is presently in storage nuclear fuel resources adequate to supply the nation's electric energy requirements for the next century, provided we elect to use the breeder technology. Under present national policy, we are wasting 99.1% of the fuel availability for use in light water reactors. Given the finite limitations on energy available to the world community of nations, we can ill afford the luxury of turning our back on this virtually inexhaustible resource.

We urge the Administration to move expeditiously in reaching the decision, based upon existing research information, to provide the administrative framework within which a viable nuclear technology, including the breeder option, can be developed and re-instituted. Such decisions must address the need for insuring sufficient fissionable resources and enrichment capacity, providing development of fuel reprocessing facilities, a breeder fuel cycle and a permanent disposal technology for high level wastes. We also urge prompt construction of the Clinch River Liquid Metal Fast Breeder Reactor.

Such action will permit our nation to begin to regain its leadership role in the international nuclear community and will materially lessen our dependence upon foreign energy sources, strengthening our nation both economically and politically.

Mrs. **Bouquard**. Mr. Taylor.

STATEMENT OF JOHN TAYLOR, DIRECTOR, NUCLEAR POWER DIVISION, ELECTRIC POWER RESEARCH INSTITUTE, PALO ALTO, CALIF.

Mr. **Taylor**. Madam Chairman, I am John Taylor, director of the Nuclear Power Division of the Electric Power Research Institute. I welcome the chance to talk about breeder reactor development.

Mrs. **Bouquard**. We are happy to have you here today.

Mr. **Taylor**. When Erico Fermi, a little over 40 years ago, showed that he could control the chain reaction so that nuclear power could be made useful for electric power generation, he also had very clearly in his mind the potential of the breeder reactor, and stated it was the full realization of the potential of nuclear power. The question is, what have we done in these 40 years-plus that have passed since he had that vision?

I think we can be quite proud of the accomplishments made with the first generation of light water cooled nuclear plants, with more than 250 of them producing power around the world, 12 percent of the electric energy in the United States and about a quarter of the electric energy in other countries such as Sweden, Switzerland, Belgium, and France, and doing it at lower cost and with less environmental penalty than most alternate methods and with an unprecedented safety record.

In the breeder program we have also made substantial accomplishments in this time. We have clearly established the technical feasibility of the liquid metal fast breeder reactor [LMFBR] powerplant. Countries around the world, including the United States, have built demonstration test reactors, and in France, the Soviet Union, and the United Kingdom, major demonstration LMFBR powerplants are in operation today, operating quite successfully.

I have furnished you, for the record, a brochure of these breeder powerplants around the world that are presently running, and running well, to establish the technical capability of these systems.

Now we still have a long way to go. We have not yet closed the gap of economic competitiveness for the breeder. It is our judgment that this system, among all the other alternates which have potential for opening up large energy resources, is closest to closing that competitive gap. We have about a 40 percent capital cost reduction to close that gap, if one looks at the progress the French have made in their big plant—Super-Phoenix. This compares to factors of perhaps 3 to 10 to close the gap with some of the other systems.

Present projections of electricity demand and fuel supply indicate that the urgency of breeder development has been reduced. However, as these changes in supply and demand, have occurred, essentially every other change indicates continued, if not increased, urgency for breeder development. The world has become less stable politically and, thus, more prey to disruptions in international energy supplies of fossil fuels. Alternate energy development and demonstration programs are not making the progress that had been anticipated; as an example, the synthetic fuel programs. New environmental concerns are being highlighted in the fossil fuel combustion and chemical industries.

Careful studies of worldwide, long-range energy needs, such as the International Institute for Applied Systems Analysis work, "Energy in a Finite World," have clearly confirmed the need of nuclear power and a breeder to satisfy minimum needs for energy for the world's growing population, assuming major exploitation of coal and renewables. I am also providing a copy of the EPRI study, "Generating Capacity and U.S. Electric Utilities," based on data through calendar year 1981, which identifies concern that U.S. electricity demand might be substantially greater than the utilities' ability to respond. Admittedly, all projections of this nature are subject to significant uncertainty, but the consequences to society for shortfalls caused by errors in such projections are far more serious than the consequences of being overprepared.

The major reason we have a long way yet to go in breeder development is that the standards imposed both by society and the industry for successful achievement of this development are far more rigorous than they were in Fermi's day. The old standards were simplistic: To demonstrate technical feasibility and economic competitiveness. The new standards are manifold.

In addition to technical feasibility and economic competitiveness, society demands that the environmental impact of widespread commercial use of the technology be assessed, and proven to be acceptable, during the development and demonstration phases. Society also demands that during the development and demonstration phases the system be proven to be sufficiently safe, so that when deployed on a large scale they will represent an insignificant increase in the risk to the public.

The industry, in discharging its responsibilities to both its investors and to the consumers it serves, has also added more rigorous standards of acceptance. It insists that the development and demonstration phases establish unambiguously the licensibility of a reactor system and its accompanying fuel cycle. The reliability and availability of the systems to be used commercially must be proven before the commercial phase is reached. The abilities—that is, operability, constructability, and maintainability—must be demonstrated.

There is no interest in repeating the experience of the first generation of nuclear plants in proving out these latter acceptance standards during the commercial phase.

Experience has shown that the simplistic standards can be demonstrated by substantial amounts of laboratory testing work and perhaps as little as one demonstration plant, but to meet the rest of the standards requires substantially more testing, more laboratory work, and more experience in the building and running of demonstration powerplants.

The Clinch River breeder reactor will be the first such step for powerplant demonstration in the United States, and it is just entering into construction. It is going to take about another 20 years, to complete the development and meet all these standards, if we maintain a reasonably aggressive rate of development—certainly faster than the pace in the Clinch River project that was permitted by the previous administration.

In keeping with its role as the research and development arm of the utility industry, EPRI has set up an effort to work jointly with DOE in the planning of a large commercial-size, prototype plant. These plans are being developed from experience gained in completing and operating the Clinch River project, utilizing fuel proven in the fast flux test facility [FFTF] and benefiting from the EBR-II experience and the continuing DOE-base technology breeder program.

We are also exploring, in cooperation with DOE, the possibilities of increased cooperation with other countries so that the excellent experience they are gaining from breeder powerplant design, construction, and operation, particularly the excellent work being done in France, Japan, the United Kingdom, and Germany, can be fed into the United States large plant development.

The specific means we have taken to pursue these tasks has been the formation of a small program management office in Chicago called the Consolidated Management Office, COMO. The office is staffed by a nucleus of highly experienced engineering managers from the breeder program who have been generously loaned to us by the major U.S. contractors, both the reactor manufacturers—GE, CE, Rockwell, and Westinghouse—and the architect/engineers—Bechtel, Stone & Webster, Burns & Roe—along with senior utility personnel who have either been loaned or who were transferred to us. When I say "generous," I mean that literally, because the companies have not only moved these people from their staffs and their own use, but are paying their salaries and benefits as well as relocation costs.

COMO is headed up by Dr. Clark Gibbs, who has had extensive nuclear experience in the naval nuclear program, the Clinch River program, and the commercial light water reactor program.

COMO is acting as a technical integrator for DOE in the large-size, prototype breeder program with the effort strongly focused on the acceptance standards I have just discussed. COMO is identifying potential improvements in capital costs to close the competitive cost gap, establishing safety design criteria and licensing standards, and defining the requirements which will assure the abilities.

We are working closely with DOE to extend what has been an excellent ongoing exchange of basic technical information among the national breeder programs arranged by their respective governments. We want to extend these exchanges into design, fabrication, construction, detail testing, and operational data, which has been quite a limited exchange among these countries up to this time. In that way the burden of resource allocation for this very demanding development will be shared and the development risks will be reduced for each of the individual countries involved.

The key role which the Clinch River project would play in such a cooperative program is described in a paper which I am also submitting with this testimony, entitled "The CRBR as the Cornerstone of the U.S. LMFBR Program."

The prospects for international cooperation, we admit, are ambitious and will be difficult to achieve, but the reward is substantial for each of the countries that would participate.

This vision of Fermi, who was really part of the first fruitful international collaboration in nuclear development, has been confirmed. We know we can build reactor plants and fuel cycle facilities that can provide centuries of additional fuel supply. The task ahead is to demonstrate that the most rigorous standards of safety, economic competitiveness, environmental protection, proliferation resistance, and performance reliability can be met before widescale deployment of this vital capability is initiated.

Thank you.

[The prepared statement of J. J. Taylor follows:]

THE CRBRP AS THE CORNERSTONE OF U.S. LMFBR PROGRAM

By

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Wallace B. Behnke
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and

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Background

To qualify as an option for significant commitments in the utility sector, bulk electric power generation systems, whether they be nuclear or nonnuclear, will have to evolve from a base of knowledge, preferably buttressed by ongoing research, development, and test activities, into selected plant-type configurations of predicted performance. Experience has demonstrated the prudence and cost-effectiveness of proceeding in an orderly manner through the design, construction, and operation of a number of systems of increasing size. These generally can be grouped in the following three categories:

Small, Experimental, Research, and Test Facilities
Intermediate-Size Demonstration Plant(s)
Commercial-Size Prototype (CSP) Plant(s)

A continuing base technology and engineering program is required to establish and maintain the necessary body of knowledge, particularly technical and economic data, to achieve reproducible quantifications of equipment, personnel, and procedures, to effectively utilize experience from the operation and maintenance phases, and to allow effective transition through these relatively expensive and complex categories of engineering development.

As with the Light Water Reactor program, the U.S. LMFBR program has been committed to this approach for over 30 years. As shown on Figure 1, the U.S. has supported a number of small, experimental, research, and test reactors in the first category. Notable among these was the Experimental Breeder Reactor I, EBR-I, which was operated in the early 1950s. The EBR-I verified the concepts of breeding and demonstrated that a liquid plant could produce steam to turn a conventional turbine generator. In fact, this plant was the first plant in the world to produce electric power from nuclear energy. A follow-on plant, EBR-II, went into operation in the early 1960s and continues to provide fundamental operational experience. The Fast Flux Test Facility, FFTF, which was brought on the line last year, is the world's largest test reactor and, as such, will provide essential research and test functions for the LMFBR program, as well as providing significant operational, maintenance, and training experience with liquid metal systems and equipment.

The U.S. program for an intermediate-size demonstration plant is focused on the Clinch River Breeder Reactor Project, CRBRP. The 350-MWe size CRBRP was carefully selected to minimize the scale-up risk from FFTF and yet serve as the necessary intermediate-size demonstration plant prior to proceeding with a full-scale commercial prototype plant. The design is almost complete, licensing has begun, and over 1.2 billion has already been spent on this project and more than $630 million worth of components either have been manufactured or are on order. This plant, coupled as it has been to the FFTF activities, has been the cornerstone and primary focus of the U.S. LMFBR base technology and engineering program for the past decade. It will serve as a testing and training center for the U.S. fast reactor program for many decades. President Reagan, in his October 8, 1981, nuclear power policy statement, emphasized the importance of completing the Clinch River Breeder Reactor Project as part of the overall development of the LMFBR.

Completion of the CRBR project is necessary to verify most of the essential features of an LMFBR in a utility environment. The demonstration of the components in a single system gives the confidence to move to the third step, that is, the design, construction, and operation of a commercial-size prototype plant. For the past few years, the U.S. has supported conceptual design studies for this follow-on plant under what is presently called the Large Developmental Plant (LDP) program of DOE. While these studies initially looked at a number of plant arrangement alternatives, the detailed studies used, as a basis, the concept underlying the CRBR. As breeder development proceeds in the U.S., and perhaps in association with the efforts of other nations, the engineering and operating information obtained from CRBR will be of great value regarding of the overall configuration used for future reactors.

International Breeder Programs

Other nations have designed, constructed, and operated small, experimental, research, and test devices and either have under design or are currently operating intermediate-size demonstration plants. Some have under construction commercial-size prototype (CSP) breeder plants. These foreign programs have primarily focused their attention on the design and construction of breeder plants. While the U.S. commitments have included a significant number of plants, the U.S. also has recognized a need for, and has supported, a broad and in-depth technology and applied engineering base program in areas of fuel, physics, safety, high temperature materials, sodium technology, component design, and testing, coupled into an extensive network of single and multipurpose facilities. Figure 2 shows the current status of the world's five independent breeder programs.

From the standpoint of construction of prototype reactor plants, the U.S.S.R. and France have the two most advanced breeder reactor development programs. The U.S.S.R's BN-350 plant of Fort Sevcenko on the Caspian Sea produces 150 MWe of power and desalinates thirty-two million gallons of water per day. This plant was initially operated in 1972. In addition, the U.S.S.R. has announced initial start-up of BN-600 (600 MWe), a commercial-size prototype plant near Beloyarsk (1,000 miles east of Moscow).

France's intermediate-size demonstration plant is the 250 MWe Phenix plant at Marcoule, which has been in operation since 1973. This plant has operated with extremely high availability for the past nine years. The French CSP is the 1200 MWe Super Phenix plant near Lyon, which is well along in construction and is scheduled for initial operation in 1984.

Germany, with assistance from Belgium and The Netherlands, is constructing the 300 MWe SNR intermediate-size demonstration plant. In 1977, Germany, with its partners, Belgium and The Netherlands, along with Italy, joined with France to form a European Fast Breeder International Cooperative Program designated SERENA. SERENA is structured to enter into license agreements with other countries which may wish to obtain the breeder technology of their European partners.

The U.K. and Japan initiated fast breeder programs a number of years ago. The U.K.'s intermediate-size demonstration plant, PFR, a 250-MWe plant at Dounreay, Scotland, has been in operation since 1975. The Japanese started up their experimental plant, Joyo, two years ago, and their 300-MWe intermediate-size demonstration plant, Monju, is scheduled for operation in 1988.

Figure 3 shows the growth of breeder reactor plants in each of these countries. The basic objectives of each of these programs are the same and total cost to complete each of the programs is high. Although technology exchange programs have existed for years, it is reasonable to consider further international arrangements of these breeder plant programs to avoid unwarranted duplication of efforts, to reduce risk, and to give added assurance of success. The present administration has emphasized this by stipulating in the President's budget for fiscal year 1983 that continued funding of the LDP program is contingent on developing international cooperation. There has been some international cooperation to date in the form of technical exchange agreements among the governments involved, limited to the more basic research and development programs and general plant information. There have been difficulties in developing exchange agreements for the detailed engineering, construction, and operational experiences being gained from the larger experimental and demonstration plants. Increased cooperation in these latter areas would be the prime ingredient of further international exchanges.

There are many possible combinations and forms which international cooperation on the breeder program can take; however, two possibilities are fairly obvious when considering the various stages of development and general considerations just discussed. They are (1) a license arrangement with SERENA to obtain European Breeder technology, including Phenix and Super Phenix experience, or (2) a joint program combining the technologies and projects of the U.S., Japan, and the U.K., or (3) a combination of the previous two forms.

With seven years of successful operation of the Phenix plant and with the expected completion of the 1200 MWe Super Phenix plant by 1984, France, through SERENA, favors commercial licensing of their technology. Negotiations to obtain a license would have to recognize the much different characteristics of the R&D program and schedules for breeder demonstration and commercial utilization currently between the U.S. and France. Morever, differences in the roles of government and industry, in R&D demonstration and commercial oriented activity, in siting, licensing, regulatory matters, and in the utility and nuclear industry infrastructure and financial and institutional constraints must also be recognized in order to achieve a workable arrangement. The challenge is to produce technology transfer and commercial licensing formulae which recognize such differences as well as the U.S. R&D strength underpinned by FFTF and CRBR and, at the same time, equitably compensates France for information which could bring about major advantages to the U.S. breeder program.

While there are also some significant differences in the roles and responsibilities (as there are with France), the U.S., Japan, and the U.K. have comparable progress and objectives in their demonstration and commercial program at this stage. Thus, their programs could meld well, allowing considerable gains over an approach in which each country proceeds by itself, and providing greater assurance that the utilities in the participating countries will have a firm basis on which to order commercial breeder reactors in the next century.

CRBRP in International Breeder Program

Without CRBRP, the U.S. would be looked at as a much weaker partner in an International Breeder Program focused, as it must at this stage, on demonstration and commercialization objectives. CRBRP is required in order that the U.S. can bring the design, development, construction, operating, and commercial licensing experience of this intermediate-size demonstration plant as its principal contribution, along with FFTF experimental and operational activities, to the International Breeder Program. The demonstration of the advanced core of CRBRP is of particular importance because of its promise of improved breeding characteristics and more adaptable core structures. The most modern techniques of structural and seismic design, which have been incorporated into CRBRP, are of prime interest to the other nations. CRBRP will also demonstrate to foreign partners that the U.S. regulation and licensing process can be met with an LMFBR plant. While FFTF used the government's "Parallel Procedure" process through the Regulatory, ACRS, and Environmental Reviews, as have other government reactor projects, the CRBRP is currently plowing new ground in commercial licensing at this time. All CRPB plant systems have also been reviewed and updated to reflect the lessons learned from the TMI accident and other potentially applicable civilian nuclear power experience in the U.S. and abroad. Clearly, the CRBR and its affiliated support programs, including results from the FFTF and the other major test facilities, will provide a sound basis for proceeding with subsequent LMFBR plants in the U.S. This other contributions will include fuel types and core arrangement concepts, component size extrapolations, its features common or adaptable to large commercial-size plants, and the significant commonality of its engineering and technological details with those variations of plant arrangement concepts that may be of interest to potential utility customers in the U.S. and abroad. CRBRP experience and technology would be a vital part of the U.S. contribution in the pooling of experience leading up to substantive internationalization of the breeder.

Advanced Core Design. The advanced CRBRP core design represents a major step beyond the fuel and core performance of test reactors, primarily FFTF and EBR-II in the U.S. as well as the overseas breeder programs, toward demonstration of the technology necessary for Commercial-Sized Prototype plants. The CRBRP design utilizes a radial heterogeneous configuration, limited free bow core restraint, and extensively tested primary and secondary control rod systems. This design is based on more than a decade of focused U.S. base technology development in reactor physics, fuels, and materials, and core mechanical and thermal-hydraulic behavior which represents the most extensive core technology program in the world.

The radial heterogeneous core configuration used in CRBRP features fertile blanket, or breeder, assemblies dispersed among the fuel assemblies. This has two specific advantages over the homogeneous configurations used for prior test and demonstration reactors. First, the breeding performance is significantly improved over a homogeneous core using the same fuel design. Second, the safety margins for this configuration are larger and more easily demonstrated.

The limited free bow core restraint design utilizes two planes of fixed load pads on the core assembly ducts, or channels, which are placed axially such that the interaction of the duct mechanical stresses and the restraint provided by two core barrel rings result in positive assembly positioning, predictable and acceptable power reactivity coefficient, and core compactness to eliminate potential anomalous reactivity effects. Although considerable test and analytic work supports the design, operation of CRBRP is necessary to combine all the environmental factors to fully demonstrate anticipated performance.

The two control rod systems incorporated in the CRBRP core design are based on approximately a decade of design and testing, and provide highly reliable, redundant reactor shutdown. Operation of CRBRP will demonstrate the satisfactory performance of these systems in a power reactor environment and firmly establish the basis for similar design of commercial plant control systems.

Component Scaling. Commercial LMFBR power plants are expected to have capacities in the range of 900 MWe to 1500 MWe. The largest LMFBR units in the United States are represented by the FFTF and the (deactivated) Enrico Fermi plant, each designed for 400 MWt. The scale-up from the FFTF size directly to a commercial plant size would represent too great a technical risk. The CRBRP thermal plant rating of 950 MWt was selected as an intermediate size which will (1) involve limited risk associated with the scale-up from existing technology, while (2) providing the requisite experience and design base from which to proceed with plants in the commercial-size range. This size constitutes a scale-up of FFTF thermal power by a factor of about 2.5, while the commercial plant thermal power could be about 2-4 times the CRBR thermal power rating. See Figures 4-7 which show size extrapolation of fuel elements, IHXs, pumps, and steam generators for FFTF to CRBR to CSP. Fabrication and operating experience in the United States indicates that power rating increases of a factor of 5 or more are imprudent, while factors of 2 to 3 involve acceptable risk. This is consistent with the pattern of every other nation developing nuclear power plants and their evaluations of the balance between scale-up of each new plant and its associated risk. As a result, each country has selected an intermediate size in all cases for first time breeder demonstration plants to verify the results of their research and engineering programs and to demonstrate the potential for commercial success.

CRBRP Characteristics Common to a Commercial-Size Plant. There are a number of fundamental characteristics of large LMFBRs which are not particularly sensitive to size, or to variations of reactor plant arrangements, and which can be demonstrated convincingly in a medium-sized reactor such as CRBR, particularly where extensive testing has been performed in other single-purpose facilities. These include basic properties and characteristics such as high temperature materials properties, thermal-hydraulic characteristics, physics, bulk fuel performance, and safety-related responses to particular events. In addition, much of the equipment, components and systems have fundamental features and characteristics which are readily demonstrated in CRBRP with its flexibility to accommodate replacement components and fuel types and core configurations in future years for demonstration in a plant environment.

Thermal hydraulics is an area of engineering which enters strongly in the design of advanced energy-producing systems. Although the required fundamentals are well-known, application to CRBRP will provide verification in an actual system to prove the adequacy of the analyses and designs selected and to give confidence that the methods can be extrapolated to larger systems.

Some of the CRBR design and safety features and characteristics directly applicable to the design and licensing of future commercial plants are listed on Figure 8. The applicability of these features to operation, maintenance, and training programs is also noteworthy.

Thus, CRBRP provides considerable information which prototypes the fundamental characteristics of commercial-scale LMFBRs. This prototype information is being generated at every step of CRBRP; namely, design, development, fabrication, construction, maintainability, and reliable and safe operation. Furthermore, this generation is underpinned by one of the worlds' most extensive and in-depth R&D programs reinforced by a wide spectrum of unique experimental and test facilities.

Potential Value of CRBRP to Future Reactor Plant Arrangement Concepts. As with most other reactor plants concepts (light water, gas, heavy water, etc.), over the years a number of basic reactor plant arrangements have evolved, been developed, and built. Such is the case with liquid metal, also. While some in the early years utilized only a primary liquid metal system directly heating the steam system, universal practice has evolved to using primary and secondary liquid metal systems, with the secondary system heating the steam system. Another significant engineering characteristic that is still being pursued in current and planned reactor plants relates to the relative degree of compactness and integration of the primary liquid metal system. In one concept, referred to as the "pool type," all primary sodium is contained in a single large vessel (that is, "pool") which contains the reactor, the primary coolant pump, and the intermediate heat exchangers. The other concept is referred to as the "loop type" and the three basic elements are laid out in the conventional approach utilized by the light water reactors with primary coolant pipe connecting each major component. In the loop concept, these three basic elements are separated into their own shielded compartments and are connected by a primary piping system. Relative merits of these two concepts have been examined by many nations as evidence by the summary of their use on Figure 9. In general, these evaluations have concluded that either concept can be designed, licensed, and constructed; and neither offers an overwhelming technical or cost advantage. Clearly, in the U.S. the utilities designers and manufacturers have preferred to rely upon the extensive experience with the "loop" configuration and the orientation of the R&D program and light water reactor programs in the U.S. and abroad. On the other hand, the experience with the gas reactors that have used the "pool type" in the U.K. and France have incurred the interest and support of those nations and others, as reflected in Figure 9, for their demonstration plants and initial commercial units. The Russian and the French/German programs each has a "pool" and "loop" plant within their own programs. However, there still is not a consensus on the preferred approach; nor is there evidence that suggests that one is desirable. Hopefully, considerably more experience will be obtained on intermediate- and commercial-size prototype plants of both concepts in years ahead. An analogous situation exists with present conventional nuclear plants with the pressurized water reactor and boiling water reactor designs. Each system has been in substantial use for about twenty years without a resolution as to which is superior.

In any event, repeated evaluations have indicated that the majority of R&D, design, and operating experience from CRBR is directly applicable to these two arrangement concepts, as well as others that could be anticipated in future years. Furthermore, there is a practical limit to the capability of any single plant to demonstrate more than one major plant arrangement concept from amongst a number of very valid and interesting competitive approaches in every technology. In general, the "customer" who pays the bill makes the final selection from a number of alternative arrangements at the time the commitment is made.

Conclusion

The CRBRP represents the culmination and integration of more than 30 years of development that have already been accomplished in the U.S. It has been reviewed extensively, and found to be the best of many options. Its construction and operation is required for the U.S. to demonstrate its capabilities to move to the next critical step, the Commercial-Size Prototype plant. In addition, it is a necessary ingredient for the U.S. to enter into international agreements for an integrated multinational LMFBR program to reduce the costs of this next step and to give added assurance of success.

As such, CRBR is the cornerstone in the future U.S. LMFBR program.

Mrs. BOUQUARD. Thank you.

STATEMENT OF JOHN YASINSKY, GENERAL MANAGER, ADVANCED POWER SYSTEMS DIVISION, WESTINGHOUSE ELECTRIC CORP., PITTSBURGH, PA.

Mr. YASINSKY. Good morning, Madam Chairman and members of the subcommittee. As always, it is a distinct pleasure to appear before you.

I am John Yasinsky, general manager of the Advanced Power Systems Divisions of Westinghouse Electric.

Westinghouse has been and is involved in various areas of advanced energy development, both nonnuclear and nuclear, including significant involvement in the liquid metal fast breeder reactor program.

I am pleased today to have this opportunity to discuss what I consider to be several important issues related to the Clinch River breeder reactor project, a project that I feel is crucial to the continued long-term growth of the Nation.

Since passage of the Budget Reconciliation Act in August 1981, which called for completion of Clinch River as expeditiously as possible, the project has made dramatic progress. Indeed, the only factor now limiting the expeditious completion is the availability of sufficient funding.

Today the design is about 90 percent complete, the research and development is approaching 98 percent of completion, and almost three-fourths of all of the hardware is complete or on order. Forty percent of this hardware cost has already been incurred, and all major long-lead procurements have been made, with most under firm fixed price contracts. The remaining procurements are essentially off-the-shelf items.

The project has achieved unparalleled success in the licensing process and in related actions in the Federal courts. In September 1982 the Nuclear Regulatory Commission authorized site clearing and excavation, and that work will be completed by November of this year.

In February of this year, the NRC Licensing Board is expected to issue a decision resolving all contested environmental and radiological site suitability issues that were raised by the Natural Resources Defense Council in the fall of 1982. Hearings on all safety issues will be heard in the summer of 1983, and a contruction permit is expected in the fall of 1983, this fall. This will enable permanent facility construction to commence upon completion of the preliminary site work, the site excavation work that is taking place at this time.

In the past 2 years, and despite all odds against it, the project has met or exceeded the highest expectations for progress in regard to every factor within its control. The only remaining factor that could extend the schedule or increase the cost, would be insufficient funding.

The Clinch River project should be completed for several significant reasons: Both early water reactor experience and the experience of every breeder reactor program throughout the world have established the need for an intermediate-sized demonstration plant as part of the R&D process. Clinch River serves that purpose.

Next, the technology inherent in Clinch River is the most advanced in the world today. The costs of the project are now very well defined. The project has been judged to be well managed, and termination of the project would represent a serious financial and technological loss.

I would like to expand my comments on a few of these items.

First, the Clinch River breeder reactor has been repeatedly challenged as being technologically obsolete. When I meet people who have brought this allegation up, I ask them why, and I have not gotten an answer yet. These allegations have never been substantiated. Rather, Clinch River is the most technologically advanced breeder design in the world today.

Some people indicate that the pool design that is being pursued by the French is more advanced. They don't realize that we in the United States invented that design; it is inherent in EBR–II that is operating today. It will be decades, if ever, before we see that one concept is better than the other. In fact, attached to my testimony is a document which shows that 85 percent of the design for a pool or loop is common.

The Clinch River design is based upon over three decades of the world's most intense, breeder technology program and incorporates more than 1,000 of the latest technological advances. A list of 23 major and unique design features that most impact cost and performance, and a comparison with foreign breeders, are included in my statement.

This comparison shows that all the foreign breeders have some of these important features, but only Clinch River has them all. The bottom line is from the point of view of technical adequacy Clinch River is at least advanced, and in many areas it is more advanced than any breeder reactor design anywhere in the world today.

Many of Clinch River's design innovations were developed through the U.S. breeder reactor base technology program that has existed at the Hanford Engineering Development Laboratory in Washington for several decades. This program has culminated with the construction and the very successful operation of the fast flux test facility, the most advanced test facility of its kind in the world.

We are very proud that the fast flux test facility was recently named by the National Society of Professional Engineers as 1 of the 10 most outstanding engineering achievements of 1982.

Clinch River, then, is based on nearly 40 years of broad experience. It incorporates the best features from breeder plants all around the world. There is nothing obsolete about this plant design, nor the overall U.S. breeder technology program.

Next, Clinch River costs are well defined. The DOE estimates that the Clinch River plant total project will cost $3.6 billion through the 5-year demonstration period.

Last December GAO issued a report giving their estimate of what the plant will cost. This report, if you look at it, essentially substantiates the official project cost estimate. However, the report has been grossly misinterpreted; it has been used by project critics to substantiate claims that Clinch River will cost around $10 billion. GAO's actual Clinch River base cost estimate, provided in this report, neglecting such traditionally nonexpenditure items as imputed interest, is about $4.5 billion through the 5-year demonstration period. An analysis of the discrepancy between the two cost estimates, 3.6 and 4.5, shows that there is no justification for the GAO's additional $900 million. On actual plant capital cost there is no discrepancy. The report states, and I quote:

> GAO found no basis to question the appropriateness of cost estimates for plant construction and major reactor and non-reactor components (the plant capital cost). These costs represent approximately $3 billion of the total estimate.

When the inconsistencies involving noncapital costs are removed, the GAO report, as I stated earlier, substantiates the official project cost estimate of about $3.6 billion.

A 1978 report by the Rand Corp. entitled "A Review of Cost Estimation in New Technologies," further verifies this cost estimate. The report states that when a project reaches what they call the definitive estimate stage, the project costs are expected to be within plus or minus 5 percent of actual. Reaching this definitive estimate stage occurs when project engineering is complete, Clinch River is 90 percent complete; when vendor quotes have been received, 75 percent of vendor quotes are out, firm fixed price; and when schedules have been finalized and construction is ready to begin; Clinch River is there. Clinch River is clearly in the definitive estimate stage.

To put Clinch River costs in a little different perspective, I would like to offer a comparison of capital costs.

Clinch River's capital costs—that is, the cost of building the plant—when it goes on line in 1990 will be in the range of $6,500 to $7,500 a kilowatt. It is an R&D project never intended to be commercially economic. However, at its time of completion, Clinch River's capital cost will be less than 2½ times that of a commercial nuclear powerplant coming on line at that time.

A comparable example is the Shippingport Atomic Power Station. As you know, Shippingport was the first demonstration that nuclear power could produce electricity within the U.S. utility framework. When Shippingport went on line in 1957, it had a capital cost in the neighborhood of $2,000 a kilowatt at a time when other electric powerplants averaged $135 a kilowatt. In other words, when Shippingport came on line, it cost 15 times as much as the technology that existed at the time of its initial operation. Yet, within 25 years, the industry which Shippingport spawned is worth $150 billion, employs hundreds of thousands of workers, and provides the most economic source of electricity available today.

In 1982 alone nuclear power accounted for $14 billion in construction jobs and accounted for over 12 percent of the Nation's electric power.

Like Shippingport, Clinch River's main goal is not to be economically competitive but to demonstrate the viability of a new energy technology, and like the light water reactor industry born through Shippingport, the breeder has similar potential to create a multibillion dollar industry employing thousands and fueling the Nation's economic growth.

Now the Clinch River project is well managed. Clinch River is one of the most thoroughly and frequently reviewed and audited projects in history. Some 425 documented, independent Federal audits have confirmed the merits of the project.

To evaluate project management performance, it is necessary to consider project cost control. The first realistic cost estimate of $1.74 billion was developed in 1974 following selection of project contractors and completion of plant conceptual design. Today's official plant cost estimate, as I mentioned, is $3.6 billion, but only $600 million of the $1.9 billion increase can be attributed to internal causes, such as design improvements and refinements in cost estimates. The balance of the cost increase resulted from events beyond the project's control, the main contributor being the delay imposed by President Carter in 1977. This amount of increase outside the control of the project has been substantiated in a recent inspector general's audit.

In light of this, it is not surprising that allegations of project mismanagement cannot be substantiated. Quite the contrary is true. Based on those cost increases within the project's control that I mentioned, Clinch River's cost has increased an average of only 4 percent a year at a time when the inflation rate was over 10 percent and other plant construction projects were escalating anywhere from 13 to 20 percent a year.

Clinch River's management record is one of which we are very, very proud.

Lastly, abandoning Clinch River would be a serious loss to the Nation. Contrary to what many have said, termination of the Clinch River project will not necessarily save money. The combination of the $1.4 billion already spent and closeout costs in the neighborhood of $300 million will result in a taxpayer loss of $1.7 billion, with basically nothing to show.

Abandoning Clinch River would be another step along a trend line that I personally feel is frightening. That is, we are gradually moving the United States further away from worldwide technological leadership, a trend that has already occurred in industries such as steel, automobiles, and electrical appliances, and is in the process of happening in areas such as transportation technologies, heavy manufacturing, solid state electronics, and telecommunications.

The energy research, development and demonstration of the fast breeder reactor, which has been chartered and supported under the auspices of this subcommittee for more than two decades has proven to be a hallmark success to date. The United States today is in the enviable position of having advanced breeder reactor technology in the forefront of world industrial capability.

Completion of Clinch River will cost as much as a few weeks' worth of imported oil. This, I believe, is a small price to pay not only to demonstrate that breeder technology can work in the U.S. utility framework, but to show other nations around the world that America is dedicated to developing technologies whose ultimate benefits will reach far beyond our own borders.

Thank you very much.

At this point I would like to pass the baton to our anchorman today, Dr. Richards, of General Electric Corp.

[The prepared statement of John B. Yasinsky follows:]

STATEMENT OF DR. JOHN B. YASINSKY

WESTINGHOUSE ELECTRIC CORPORATION

BEFORE THE

U.S. HOUSE OF REPRESENTATIVES

COMMITTEE ON SCIENCE AND TECHNOLOGY

SUBCOMMITTEE ON ENERGY RESEARCH AND PRODUCTION

February 23, 1983

MADAME CHAIRMAN, and members of the Subcommittee,

I am John Yasinsky, General Manager of the Advanced Power Systems Divisions of Westinghouse Electric Corporation. Our company is involved in the development of various advanced nuclear and non-nuclear energy technologies, including the Liquid Metal Fast Breeder Reactor. We play a lead role in support of the Department of Energy on the Clinch River Breeder Reactor, and participate in follow-on large plant studies and the LMFBR Base Technology Program. Through the Westinghouse Hanford Company, we operate the Hanford Engineering Development Laboratory for the Department of Energy and, in that capacity, we are also responsible for the operation of the Fast Flux Test Facility.

I am pleased to have this opportunity to discuss several important issues related to the Clinch River Breeder Reactor Project, a project crucial to the continued growth of our nation.

U.S. LMFBR Program and the Role of Clinch River

The U.S. has a structured and mission oriented breeder reactor program. EPRI, DOE and other studies, which include projections of uranium availability and price and nuclear power growth, indicate a probable need for commercial breeders in the U.S. starting about 2025. Taking this and future world-wide growth in uranium demand into account, the present schedule for the introduction of breeder reactors is a reasonable one. Present plans call for the completion and start-up of the Clinch River Breeder Reactor by 1990. This would then be followed by detailed design, construction and operation of a commercial prototype reactor by the turn of the century. This follow-on plant will be financed by the private sector; planning for it is already underway. Operating data gathered from FFTF, Clinch River, and several years operation of U.S. and foreign commercial prototypes would then be available to design an economically competitive commercial breeder. This first commercial plant would be operational by 2020 at the earliest. By then, a better understanding of uranium availability and cost and nuclear power growth will have been achieved. Also, Clinch River will have been operating 30 years, and LMFBR efficiency will have been proven. An orderly introduction into the utility market can occur.

Let's return to the present and the Clinch River Breeder Reactor. In a recent report entitled "The Liquid Metal Fast Breeder Reactor - Options for Deciding Future Pace and Direction", the GAO reiterated advice it has offered Congress several times over the last seven years. The GAO concludes that "if the LMFBR is to be developed to the point where industry can use it, an intermediate-sized plant such as the Clinch River project is a logical and prudent step to gain important operational experience on breeder reactor performance, reliability, maintainability, safety, environmental acceptability, licensability, and economic feasibility." In other words, Clinch River is the right plant at the right time.

Clinch River's Progress to Date has been Substantial

After passage of the Budget Reconciliation Act in August of 1981, which called for completion of CRBR as expeditiously as possible, the project has achieved dramatic gains in progress. Indeed, the only factor now limiting expeditious completion is the availability of sufficient funding.

Design is 90% complete, research and development is 98% complete, and 70% of the hardware is complete or on order. Forty percent of the hardware cost has already been incurred, all major long lead procurements have been made with most under firm, fixed-price contracts; the remaining procurements are essentially off-the-shelf items. Project construction wil be undertaken pursuant to a Nuclear Stabilization Agreement with the building trades. The advanced stage of project development and planning affords high confidence that the cost estimates are valid, and that the schedular uncertainty (given sufficient future finding) is reduced to the barest minimum.

The project has achieved unparalleled success in the licensing process and in related actions in the federal courts. In September 1982, the Commission authorized site clearing and excavation, and that work will be completed by November of 1983. In February of 1983, the NRC Licensing Board is expected to issue a decision resolving all contested environmental and radiological site suitability issues raised by NRDC in the fall of 1982; hearings on all safety issues will be heard in the summer of 1983; and a construction permit is expected in the fall of 1983. This will enable permanent facility construction to commence upon completion of site excavation as scheduled. Four lawsuits filed by NRDC against the project have resulted in the shutdown of site clearing for a total of one day. At the present time, none of these actions present a significant risk of impeding progress. By the fall of 1984, the project will have successfully completed the NRC licensing process within the short space of two years. Neither licensing activities nor related litigation have or are expected to control progress toward completion.

In the past two years and despite all odds against it, the project has met or exceeded its highest expectations for progress in regard to every factor within its direct, and even indirect, control. The only remaining factor which will extend the schedule or increase the cost is insufficient funding.

The project's present favorable prospects for rapid completion are all the more impressive when it is recognized that this progress has been made during a time when lead times for conventional light water reactors have expanded up to fourteen years, and the NRC licensing process and the judicial system have combined to create an impenetrable morass for conventional reactor plants. The project's impressive record of progress warrants funding commensurate with expeditious completion.

Clinch River Breeder Reactor Project Should Be Completed

The Clinch River Project should be completed and reactor operation commenced for several significant reasons.

- Both early water reactor experience and the experience of every breeder program throughout the world establishes the need for an intermediate-sized demonstration plant as part of the R&D process.

- The technology represents the most advanced in the world.

- The costs of the project are now well defined.

- The project has been judged to be well managed. The latest GAO report reiterated this point.

- Termination of the project would represent a serious financial and technological loss.

The Clinch River Demonstration Plant Will Focus the U.S. Breeder Program

Experience has shown that the least effective way to accomplish heavy engineering development is to expend too much effort on components and not enough on the fully integrated system. Clinch River is the focus for such a fully integrated system in the U.S. breeder program. It represents a shift from testing to the construction and operation of a facility with a focused R&D mission--to prove that LMFBRs are indeed a viable energy source. One of the major differences between foreign and U.S. breeder programs is that they have built and operated plants while we have concentrated on base technology development and testing.

We must be serious about the continued use and expansion of nuclear generated electricity. This will continue on a world-wide basis. Thus the utility industry must be assured of an adequate long term nuclear fuel supply. Without the eventual introduction of breeder reactors, the long-term viability of the nuclear option is suspect. Confidence in breeder reactors cannot be gained simply through research and development and design studies. Reliability, maintainability, licensability and favorable economics must be demonstrated. The Clinch River Breeder Reactor will provide that demonstration.

The Clinch River Technology is the Most Advanced in the World

The Clinch River Breeder Reactor has repeatedly been accused of being technologically obsolete. These allegations have never been substantiated. Rather, Clinch River is the most technologically advanced breeder design in the world today.

That Clinch River is a loop rather than a pool design is one of the most often cited reasons for questioning the plant's technical adequacy. Contrary to critics' allegations, the pool design is not more advanced nor are there any indications that it is better. The pool concept was pioneered in the U.S. Our Experimental Breeder Reactor II is a pool reactor. Interestingly, there is a significant amount of commonality between the pool and loop. This is illustrated by the comparison I have included with my statement. Approximately 80 to 85 percent of the systems are common to both. Selecting the loop approach for Clinch River does not preclude using the pool on subsequent reactors. Both the loop and pool designs have excellent and equal probability of eventual commercial success.

The Clinch River design is based upon three decades of the world's most intensive base technology program and incorporates more than 1000 of the latest technology advances. A list of the 23 major design features that most impact cost and performance and a comparison with foreign breeders are included with my statement. This comparison shows that all of the foreign breeders have some of these important features, but only Clinch River has them all. The bottom line is that, from the point of view of technology adequacy, Clinch River is at least as advanced and in many areas, is more advanced than other breeder reactors around the world.

Many of Clinch River's design innovations were developed through the U.S. LMFBR Base Technology program which has existed at the Hanford Engineering Development Laboratory for several decades. The work at Hanford has provided a focus for the base technology program. This program has culminated with the construction and operation of the Fast Flux Test Facility, the most advanced test facility of its kind in the world. The FFTF was built to test fuels, materials and components, and to provide experience with engineered LMFBR systems. FFTF, dedicated in April of 1982 recently began its second 100-day operating cycle, one of two scheduled for 1983. Sixty-two experiments are in the reactor. During its first 100-day operating cycle, one of two scheduled for 1983. Sixty-two experiments are in the reactor. During its first 100-day operating cycle, FFTF maintained full power for 53 consecutive days, a U.S. record for sodium-cooled reactors.

We are very proud that FFTF was recently named by the National Society of Professional Engineers as one of the "Ten Outstanding Engineering Achievements" of 1982. "Successful operation," the award noted, "... reflects engineering achievements in high-temperature structural design, mechanical properties and fabrication, non-destructive testing, and coolant technology." The award also noted the excellent safety record of FFTF during both the operation and construction phase.

Hanford's success in supporting the breeder mission is not restricted to FFTF. The Fuels and Materials Examination Facility which is on schedule for completion in June 1984, will provide for non-destructive and destructive examination of test assemblies irradiated in the FFTF. Housed within this facility will be the Secure Automated Fabrication line which will supply future FFTF and CRBR fuel. This line is being designed to reduce personnel radiation exposure by using automated and remote operations, and will develop and establish the essential technology for large-scale manufacturing of breeder reactor fuel. Additional operations within this facility will demonstrate other elements of the breeder fuel cycle.

Clinch River's design is based on over 40 years of U.S. LMFBR experience, as well as incorporating the best features from breeder plants throughout the world. There is nothing obsolete about the Clinch River design, or the overall U.S. breeder technology program.

Clinch River Project Costs are Well Defined

The DOE estimates that the Clinch River plant will cost a total of $3.6 billion through the five-year demonstration period. On December 10, 1982, the GAO released their estimate of what the plant will cost, and essentially substantiated the DOE estimate. This report has been grossly misinterpreted, and has been used by project critics to substantiate claims that Clinch River will cost around $10 billion.

GAO's actual base cost estimate for the total Clinch River Project is about $4.5 billion through the five-year demonstration period. An analysis of the discrepancy between the two cost estimates shows there is no justification for the GAO's $900 million increase over the official DOE estimate.

On actual capital cost there was no discrepancy. The report states that "GAO found no basis to question the appropriateness of cost estimates for plant construction and major reactor and non-reactor components. These costs represent approximately $3 billion of the total estimate."

However, to arrive at their $4.5 billion figure, the GAO used several invalid and inconsistent assumptions associated with non-capital costs. Revenue projections were based on a six percent inflation rate while operating costs were based on a 10 percent inflation rate. The effect is to maximize cost and minimize revenue. Likewise, plant availability, contingency and fuel costs were similarly calculated based on inconsistent and unrealistic assumptions. When these inconsistencies are removed, the GAO report essentially substantiates the official project cost estimate of $3.6 billion.

To further cloud the issue, the GAO added two factors above their base cost estimate--some $4 billion in imputed interest and $2 billion in costs beyond the five-year demonstration period, which should not be considered a part of the base cost estimate. The report directly stated that "imputed interest is a non-expenditure item, and neither DOE nor the Office of Management and Budget require it to be included in the cost of government projects."

The inappropriateness of including imputed interest in Clinch River's cost estimate was reinforced recently by Robert Georgine, President of AFL-CIO's Building and Construction Trades Department and Chairman of the new Committee on Jobs, Environment and Technology. "I shudder when I think of what the cost of weapons systems, highways, or urban redevelopment projects would look like if imputed interest were figured into their appropriations," he said.

A cost estimate is just that--an appraisal of future cost based on the best information available today. A 1979 report by the Rand Corporation entitled "A Review of Cost Estimation in New Technologies" verified DOE's $3.6 billion estimate. The report states that when a project reaches the "definitive estimate" stage, project costs are expected to be within plus or minus five percent of actual. This occurs when project engineering is complete, vendor quotes have been received, schedules have been finalized and construction is ready to begin or is underway. Clinch River is clearly in the definitive estimate stage.

To put Clinch River's cost in perspective, let me offer this comparison of capital costs. Capital costs are those costs associated with the design and construction of a plant. They do not include research and development, operating, maintenance, and fuel costs.

Based on this, Clinch River's capital cost when it goes on-line in 1990 will be in the range $6500 to $7500/kWe. The Atomic Industrial Forum estimates that a light water nuclear plant scheduled to be on-line in the same time frame will have a capital cost of about $3000/kWe. At its time of completion, Clinch River's capital cost will be less than two and a half times that of commercial nuclear power plants of the time.

A comparable example is the Shippingport Atomic Power Station. Shippingport was the first demonstration that nuclear power could produce electricity within the U.S. utility framework. When the Shippingport plant went on line in 1957, it had a capital cost of about $2000/kWe, at a time when other electric power plants averaged $135/kWe. In other words, Shippingport cost 15 times as much as the technology that existed at the time of its initial operation.

And yet, within 25 years, the industry which Shippingport spawned is worth $150 billion, employs hundreds of thousands of workers, and provides the most economic source of electricity available today. In 1982 alone, nuclear power accounted for $14 billion in construction jobs and accounted for over 12% of our nation's electric power.

Like Shippingport, Clinch River's main goal is not to be economically competitive, but to demonstrate the viability of a new energy technology. And, like the light water nuclear industry born through Shippingport, the breeder has similar potential to create a multi-billion dollar industry, employing thousands, and fueling the nation's economic growth.

The Clinch River Project is Well Managed

Clinch River is governed by a project management system, developed and proven effective by the U.S. Air Force, which divides the project into thousands of work packages and milestones so that each can be closely monitored. It is one of the most thoroughly and frequently reviewed and audited projects in history. The DOE Inspector General's office has conducted 13 audits, one inspection and four investigations. And some 425 other independent federal audits have also confirmed the project's merits.

When considering the cost of the Clinch River plant, it is also necessary to look at the project management performance since the project was authorized in 1972. Although an intial budgetary estimate of $699 million was established at that time, the first realistic cost estimate of $1.74 billion was developed in 1974, following selection of project contractors and completion of plant conceptual design.

In a July 12, 1982, report, the Inspector General's Office substantiated this $1.74 billion figure as the first realistic cost estimate, and states that cost escalations must be measured against this figure.

Today's official plant cost estimate for Clinch River is $3.6 billion. Only $600 million of the $1.9 billion increase can be attributed to "internal" causes such as design improvements and refinements in cost estimates. The balance of the cost increase resulted from events beyond the project's control. The Inspector General's audit found that nearly $1.3 billion of the escalated cost for Clinch River has been due to the "national policy debate," culminating in the 1977 order by the Carter Administration to indefinitely delay the project. And $160 million is attributed to ratcheting plant licensing requirements. In all, nearly $1.3 billion of the $1.9 billion cost increase is due to factors beyond the project's control.

In light of this, it is not surprising that allegations of project management could not be substantiated. Quite the contrary is true. Based on those cost increases within the project's control (some $600 million), Clinch River's cost has increased an average of only 4 percent per year, at a time when the inflation rate was over 10 percent per year. When considering that current power plant construction projects are averaging annual cost increases of between 15 and 20 percent per year, Clinch River's management record is one of which we can be proud.

Abandoning Clinch River - A Serious Loss to the Nation

Contrary to what many have said, termination of the Clinch River project will not necessarily save money. The combination of the $1.4 billion already spent and the closeout costs of some $300 million will result in a taxpayer cost of $1.7 billion with nothing to show for it.

The efforts of thousands over the past ten years which have resulted in a breeder design more advanced than any in the world, in millions of dollars worth of fabricated equipment, in a highly trained team of technical experts, and in a project system which should serve as a model for future government/private sector cooperative efforts will have accomplished nothing.

Abandoning Clinch River would be another step along a trend line that I think is very frightening that is moving the U.S. further away from worldwide technological leadership--a trend that has already occurred in industries such as steel, automobiles and electrical appliances, and is in the process of happening in areas such as heavy manufacturing, solid state electronics and telecommunications.

The energy research, development and demonstration of the fast breeder reactor, which has been chartered and supported under the auspice of this committee for more than two decades, has proven to be a hallmark success to date. The United States today is in the enviable position of having advanced fast breeder reactor technology in the forefront of world industrial capability.

The successes of the breeder, both politically and technologically, far outweigh the diversions. Throughout the world today representatives of industry are bringing to the leaders of government the proof by way of hard data that the breeder is capable and ready to meet the global energy needs of the twenty-first century and beyond. The cornerstone upon which the U.S. breeder potential rests was laid more than 37 years ago with the inception of electrical nuclear power. It is essential for us to have a balanced national energy program if we, both government and industry, are to remain accountable within our global community.

Completion of Clinch River will cost as much as a few weeks' worth of imported oil. This is a small price to pay not only to demonstrate that breeder technology can work in the U.S. utility framework, but to show other nations that America is dedicated to developing technologies whose ultimate benefits will reach far beyond our own borders.

Thank you.

Dr. John B. Yasinsky

Westinghouse Electric Corporation

Dr. John B. Yasinsky is General Manager of the Advanced Power Systems Divisions of the Westinghouse Electric Corporation. Joining the corporation in 1963, Dr. Yasinsky was assigned to the Bettis Atomic Power Laboratory, working in reactor theory, design, dynamics and control in support of the naval nuclear program. In 1971 he was named manager of electric systems and plant analysis at Bettis.

The following year John was named to the White House Fellows Program and served as Special Assistant to the U.S. Secretary of Commerce.

Returning to Westinghouse, Dr. Yasinsky was named Manager, Business Development for the Breeder Reactor Divisions, moving through a variety of marketing management jobs. In 1978 he was appointed Director of the Advanced Coal Conversion Department which was responsible to the firm's activities in low and medium BTU coal gasification research and development.

Appointed President of Westinghouse Hanford Company in January 1979 he was responsible for the operation of the Hanford Engineering Development Laboratory for the U.S. Department of Energy. A major responsibility there is also the operation of the Fast Flux Test Facility for testing breeder fuels and materials. Work is also underway on developing and testing materials for fusion reactors.

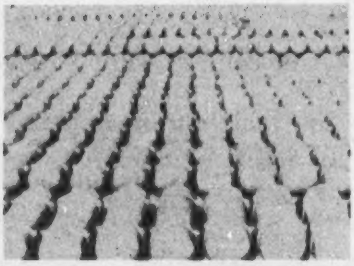
He was appointed to his present position in August of 1980. In this post he is responsible for the Advanced Reactors Division, the Westinghouse Hanford Company and the Advanced Energy Systems Division.

Dr. Yasinsky received his B.S. in physics from Wheeling College. He earned a master of science degree in physics from the University of Pittsburgh and his Ph.D. in nuclear science from Carnegie Institute of Technology (now Carnegie-Mellon University). He has authored numerous technical papers and reports and taught in the graduate programs at Pittsburgh and Carnegie-Mellon.

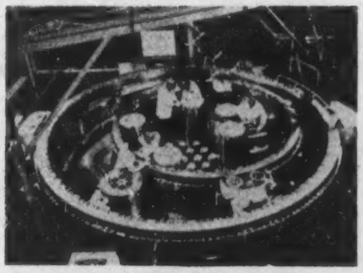
Dr. Yasinsky is a member of the American Nuclear Society, the National Security Industrial Association and has served on the Advisory Council of the National Energy Resources Organization. He is a member of the White House Fellows Association.

CLINCH RIVER BREEDER REACTOR

Official total cost	$3.6B	
Expenditures to date	$1.4B	
Cost to complete	$2.2B	
Cost to taxpayers if terminated	$1.7B	with nothing to show for it



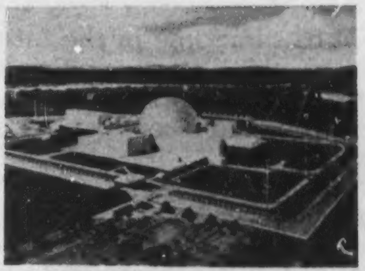
Stockpiled uranium tails worth $60 trillion if used in breeders.



$742 million worth of equipment complete or on order.

Site clearing complete; plant excavation begun.

The $2.2B needed to complete Clinch River is comparable to the bill we pay for imported oil every few weeks - it's a small price to pay for a technology that will assure America independence from the stranglehold of foreign energy sources.



Clinch River; the most technologically advanced breeder design in the world.

Mrs. **Bouquard.** Anchorman, take over.

STATEMENT OF R. B. RICHARDS, GENERAL MANAGER, ADVANCED REACTOR SYSTEMS DEPARTMENT, GENERAL ELECTRIC CO., SAN JOSE, CALIF.

Mr. **Richards.** I could, of course, make the remark that everybody has stolen my lines.

Mrs. **Bouquard.** Is that when you are the last one on a panel?

Mr. **Richards.** Yes, but I will try to invent a few new ones.

Mrs. **Bouquard.** What is even worse on my part, Dr. Richards, is you all have covered the subject so well that I am trying to decide what I am going to ask you.

Mr. **Richards.** I am Robert B. Richards, general manager of the Advanced Reactor Systems Department at General Electric Co.

Our department is responsible for the management of all reactor and fuel cycle developments that have commercial power as their eventual application, with the exception of the light water reactor applications.

Now the breeder program has been in place, the national breeder program, sometime starting in the 1950's. Of course, you are all aware that GE has been a strong participant and contributor to this program, and we propose to continue our involvement in it, since we are convinced that we have made good contributions to the program and we can continue to contribute to its advancement.

John referred to the matter of the pace or the schedule for the eventual breeder commercialization, and there is no doubt that the pace of this development and the pace of commercialization has been slowed because of events such as reduced load growth and many other institutional problems.

I think the point I want to make here is that it should be possible, and we have said this before to your committee, that these developments, these kinds of developments, are long-time cycle developments, and it should be possible, even now, to structure a national breeder program that will be paced in a way that, first, we do not lose the very substantial investment that has been made over the years in breeder technology and, second, that we can be ready to move when the time and the need is evident, and certainly it will be sometime in the future.

I would like to make some comments on the structure of the breeder program as we see it, what are the key ingredients to the program, and comment a little bit on these. There are three of them.

The first is the base technology. The Department of Energy and its predecessor agencies sponsored strong base-development programs over the years. We think, of course, that this should continue. In the years ahead we see a strong need for that base-technology program to be expanded to include a stronger emphasis on the pilot development of fuel fabrication and reprocessing techniques. We also see the need for devoting of the base-technology work to support cost reduction studies in the reactor area and other innovative breeder reactor developments that we know the private sector people are carrying out today.

For example, we have invested some of our own funds in a modular breeder concept that might lead to development plants with inherently lower costs and technical risks. We do think that the base-technology program should be—we should reorder the priorities so that we can include some of these cost-reducing studies in them.

Let me comment now a little bit on that highly popular project, the Clinch River project.

It has been mentioned very frequently that any well-balanced technology development must include a demonstration stage. The light water development, of course, had many, many demonstration stages. However, in addition to the demonstrating power generation and licensing, we think that the Clinch River reactor project can be a gold mine for technology data that will be invaluable in the years ahead.

Putting it all together would constitute a final examination for all the systems engineers, the licensing engineers, the component suppliers, and the construction engineers that have contributed so importantly to this project. Such experience we think is far more important than winning or losing the argument as to the merits of the design.

Large plant design and development—John Taylor, of course, has commented on that. I would like to add a few things to it.

Regardless of what the schedule may be for any large plant that might be built, we think that maintaining an activity, looking at large plant designs, is very, very important. We have said this before, and for a number of reasons that relate to giving the total breeder program its proper focus.

First, carrying out such a program can identify problems of technical scaleup and in this way guide the base technology work to address such problems.

The work can identify total plant economics and areas in need of cost reduction. The program is already doing that. Again, we can direct our base programs to be supportive of these problems.

Finally, the program certainly can expose safety and licensing problems early on, which is a good thing to do so that we can get to work and solve these problems very early.

We believe that if we are going to bring the LMFBR technology to the point where it is attractive to the private sector, this large plant, follow-on-type activity will be absolutely essential.

Now the present large plant design activity, as John mentioned, is going on through their COMO office with the support of many of us in the industry. COMO is making strong efforts to internationalize this activity to a useful degree. I just want to state that we in GE endorse this activity that EPRI is sponsoring and intend to continue our cooperation with COMO in carrying out this work.

Now as a final point in my remarks, I know you are all very busy people and you have staggering schedules. However, if somehow you could find the time to visit and get some progress updates—visit the Clinch River project office, visit the COMO design office, visit the FFTF, visit some of the national laboratories, even visit some of the industrial offices—I am sure, if you could find the time to do this, you would be convinced that the national breeder program is being well served by many, many dedicated people and that the international perception that the United States is no longer a leader is easily correctable and need not be of any permanence.

I thank you for your attention. That concludes my remarks.

[The prepared statement of Dr. Richards follows:]

TESTIMONY OF

ROBERT B. RICHARDS

GENERAL MANAGER, ADVANCED REACTOR SYSTEMS DEPARTMENT

NUCLEAR FUEL & SPECIAL PROJECTS DIVISION

GENERAL ELECTRIC COMPANY

ON

DOE FY 1984 BUDGET REQUEST

BEFORE THE

SUBCOMMITTEE ON ENERGY RESEARCH AND PRODUCTION

HOUSE COMMITTEE ON SCIENCE AND TECHNOLOGY

FEBRUARY 23, 1983

LMFBR TESTIMONY

My name is Robert B. Richards. I am General Manager of the Advanced Reactor Systems Department of the General Electric Company. Our Department is responsible for the management of all Reactor and Fuel Cycle Developments that have commercial nuclear power as their eventual application with the exception of the light water reactor applications.

BACKGROUND CONCERNING G.E. LMFBR SUPPORT

Previous Government energy agencies (AEC, ERDA) have supported and managed national programs for the advancement of LMFBR breeder reactor technology. The justification has consisted of a combination of attractive potential fuel costs and the prospect for a near-inexhaustible fuel supply. The present Administration and DOE have elected to continue their support of this technology. As you know, General Electric has been a strong contributor to the national breeder program since its inception in the 1950's. We propose to continue our involvement in this program since we are convinced we can make a meaningful contribution to its advancement.

PACE OF LMFBR DEVELOPMENT

There is no doubt the need for commercial versions of LMFBR power plants has been delayed. Reduced load growth and the oft-mentioned institutional problems of the nuclear industry have led to this conclusion - which is now widely accepted. The Administration and DOE have already recognized this delay through substantial reductions in their recent budget allocations for LMFBR development. As we have pointed out in previous hearings before your committee, the development/demonstration cycle for any new energy technology spans a substantial period of time. It should be possible to pace the development on such a schedule and with such a cost that we do not lose the substantial investment made to date but yet pace the program to be ready to move expeditiously when the need is evident.

STRUCTURE OF THE LMFBR DEVELOPMENT

First, let me mention that the structure of the LMFBR program must be such that the technology development can be transferred to private industry sponsorship at the earliest possible date. This is the oft-stated goal of the Administration and DOE.

Let us now state what we believe to be the essential elements of such an LMFBR development program.

Base Technology

DOE has sponsored a strong base program over the years. Great emphasis has been placed on safety development and this should continue. In the years ahead we believe the program priorities should be adjusted to expand the pilot development of fuel fabrication and reprocessing techniques as well as the work on specific development in support of private sector initiatives such as innovative reactor studies. We have invested our own funds in a modular concept that might lead to development plants with inherently lower costs and technical risks.

Clinch River Project

Sound, well-balanced technology developments must include a demonstration stage. The LWR evolution contained many demonstrations at the small or intermediate sizes. In addition to demonstrating power generation and licensing, Clinch River can also be a "gold mine" for technology data that will be invaluable in the years ahead. "Putting-it-all-together" will constitute a "final examination" for all the systems designers, licensing engineers, component suppliers and construction engineers that have contributed so importantly to the project. Such experience is far more important than winning or losing the argument as to the merits of the design.

Large Plant Design and Development

Others before you today will deal with this subject in greater detail. In our past presentations to you we have emphasized the importance of a follow-on design activity. Regardless of the schedule one might imagine for the implementation of such a follow-on project, the program is important for several reasons:

1. It can identify the problems of technical scale-up and guide the base technology to address such problems.

2. It can identify the total plant economics and the areas in need of cost reduction - again directing the base programs to be supportive.

3. The program can expose any safety and licensing problems early-on, and direct work to solve such problems.

If we are to bring the LMFBR technology to the point where it is attractive to private interests, the above follow-on activity will be essential.

The present large plant design activity is being technically directed by EPRI through their COMO office. Reactor manufacturers, architect engineers and utilities are contributing manpower to this office. COMO is making strong efforts to expand areas of international cooperation. We in GE endorse this activity.

I know you are all very busy people and have a staggering workload ahead of you. If you could find the time, however, to visit (and receive progress updates) the Clinch River Project Office, the COMO Design Office, the FFTF, the several National Laboratories and, if possible, the many industrial offices (including ours), I'm sure you would be convinced that the national breeder program is being well served by many dedicated people - and that the international perception that the U.S. is no longer a leader is easily correctable and need not be of any permanence.

We appreciate your kind attention to our views on the LMFBR program and will be pleased to answer any questions you may have.

BIOGRAPHY

ROBERT B. RICHARDS

Dr. Richards is General Manager, Advanced Reactor Systems Department, Sunnyvale, California.

He joined the Research Laboratory of General Electric in 1947 and later that year transferred to the Hanford Atomic Laboratory where he served in a variety of managerial positions. He transferred to the Atomic Power Equipment Department, San Jose, California in 1957 and was appointed Manager, Engineering, and served in that capacity until January 1968 when he was appointed Manager, Engineering of the Reactor Fuels and Reprocessing Department. In October 1971, he was appointed Manager, Special Fuel Programs, with overseas licensing responsibilities for the Nuclear Energy Division. Dr. Richards was appointed Manager, International Business Development, Overseas Projects Department in January 1973. He assumed his present position in 1974.

Dr. Richards was graduated from Pennsylvania State University with a B. S. in chemical engineering and an M.S. and Ph.D. in organic chemistry. He is a member of the National Academy of Engineering, Fellow ANS, Fellow AIChe, R.E. Wilson Award in Chemical Engineering in 1970, and is a Professional Engineer in the State of California.

Mrs. **Bouquard**. Thank you, Dr. Richards.

I agree with you. I certainly intend to move this committee in the direction of getting out of Washington for field hearings. I hope we can accomplish that goal this year in spite of our very busy schedule.

I think you gentlemen know better than I know that every year we have different arguments against CRBR; that every year as the fashions change, or used to change, a new criticism becomes in vogue. Of course, last year we saw a convergence of the antinuclear forces with those who recognize even more than the average Member of Congress the need for budgetary constraints. Therefore, the ultraconservative forces, in cooperation with the antinuclear forces, brought up the fact, "Well, hey, wait a minute, we've got to cut back on our budget," and our budgetary process dictated that we had to cut back on Federal expenditures. Therefore, the argument in vogue last year was economics: "Since we need to cut back on spending, the thing to do this year is to postpone the breeder reactor; we're not really against it, but we do think let's just put it off." I think that is going to be the major criticism this year.

Therefore, I think it is very timely that you gentlemen address these issues: the economics; the postponing of the project, that we do not need to do it right now; that it is decades away before we are going to need the technology.

Mr. **Kearney**. Let me start off—and I am sure my colleagues will add to it. I think the premise is wrong. If you have any type of a time schedule to develop a homegrown technology of this complexity, if anything, one might even assume we are behind schedule.

It is not just a matter of taking this plant and abandoning it, and then at some time in the future pick up where you left off. More importantly, as is pointed out by Dr. Yasinsky, on the current schedule we ought to be able to think in terms of a commercial breeder by the year 2020. Now that is a long time off, and I think it indicates the complexity of what we are trying to accomplish.

Furthermore, if you are to abandon Clinch River, you abandon the focus of the program. We are at a stage now where we ought to demonstrate the technology. Every other nation has done the same thing as they attempt to develop breeder technology. We are at that stage now, and I thinking that is what we ought to do.

Mrs. **Bouquard**. This also, as I view it, is our commitment to nuclear power as a nation. Without this commitment, we are not going to move forward as a reliable supplier or partner in the nuclear industry.

Mr. **Kearney**. I agree with you. In my statement I pointed out that if we are really thinking in terms of nuclear power as one of the two basic domestic resource options that we have, we have to think in terms of extending the supply of uranium. Again, it is something that we have to do now, so as to assure the future.

Mrs. **Bouquard**. Dr. Yasinsky.

Mr. **Yasinsky**. I was going to add just a few comments to what Mr. Kearney said.

Many people believe, when they hear that we may need a breeder around the year 2020, that that is so long that we should put Clinch River on the shelf and let's come back when it is time for the breeder. However, if you look at the schedule that is laid out today, if we are able to complete Clinch River and have it operating in 1990, plans are for a follow-on, prototype plant that, hopefully, could be completed and operating by around the year 2000, or a few years after.

Now if that plant is successful, then it would be at least 5 years where utilities would require operating experience before ordering what might be looked on as a commercial-type plant, and that plant at the earliest could be operating in the year 2020.

Now by that time, Clinch River would have been operating for 30 years, FFTF would have been operating a little more than that.

We also, hopefully, would have been participating in some collaborative programs with foreign countries.

My point is, with the program that is in place right now, by the time we may need breeders in the United States, going on the program we are on right now, we will have demonstrated and substantiated that the technology is ready, available, and can be used by the time that it might be needed. Therefore, we are not on an accelerated schedule.

Mrs. BOUQUARD. Do you see greater enhancement of foreign cooperation at this time as opposed to the Carter years when we were not seen as a reliable partner?

Mr. TAYLOR. We are quite encouraged by the discussions that we have entered into with the United Kingdom, with the Japanese, with the French, and through the French with the Germans. Each of these countries is also recognizing the magnitude of the development and the work that is yet to be done, even though they all have made excellent progress. They also can see the benefits of sharing this detailed operational, design, and construction information.

We are hopeful that sometime within the next year we will have formalized some of these arrangements. We are already meeting at reasonable intervals with these people and have initiated technical discussions on safety design criteria, to begin a movement toward this type of exchange. We are quite encouraged, and we think the benefits will be substantial.

Now underlying that cooperative effort is another essential matter which belongs in the development program for the breeder, and that is the resolution, through institutional agreements and understandings, of necessary controls to assure that weapon proliferation will not occur through this medium. I know of no better way to assure this than to have deep international cooperative efforts in this development program, and, as the development proceeds, prove by doing that these controls are in place and adequate.

Mrs. BOUQUARD. Thank you very much.

Mr. Chandler.

Mr. CHANDLER. I have no questions.

Mrs. BOUQUARD. Mr. Walker.

Mr. Walker is our ranking Republican on the subcommittee this year. I look forward to working with him.

Mr. WALKER. Thank you, Madam Chairman.

I was interested in a statement—I think it was Mr. Richards'—that gave as one reason for building Clinch River that it is going to be a gold mine of technological information that would be used for the future. I think that probably is the chief justification for going ahead with it.

Looking at it, though, somewhat parochially, I question the amounts of money that you are asking be spent and the cost-sharing that goes on. We have a gold mine of information up my way, too, that the industry has not been very willing to move into in terms of exploiting that technological information. It is called Three Mile Island.

Virtually everybody I talk to in the industry says that we are going to have a gold mine of information come out of that, too, that will serve the industry for a long, long time to come. We have seen a real hesitancy over the past three years of the industry to move in and exploit that gold mine of information that is readily available to it. Industry could get the kind of data that will serve not only in future problems of that kind, or solving future problems of that kind, but also will solve decommissioning problems and other concerns of a similar nature.

My question is, what kind of confidence can we have as a subcommittee that, in fact, this breeder gold mine will be exploited properly? We see that the one that is there, a major opportunity for the industry to get some information, is not being properly exploited.

Mr. KEARNEY. Let me try to respond to that, Mr. Walker.

I think the industry is in sympathy with the observations you have made about the knowledge that can be gained from the cleanup of TMI. I would further add that the investment community has told us that the industry is paying a "risk premium" on its financing as long as that cloud is over TMI. For both of those reasons, the Edison Electric Institute Board of Directors this January passed a resolution urging member companies of the Edison Electric Institute to voluntarily contribute up to a total of $150 million to the cleanup of TMI.

It is a little too early to say what is going to happen. That is over a 6-year period. However, we are already hearing word from individual member companies that they support that program. We are encouraged by the level of support that is coming in. Therefore, I think that the industry will truly make a financial contribution to the cleanup of TMI.

Now you used the word "hesitancy" in your observations about this, and I can well understand because it has been a long time. We are coming up on the fourth anniversary next month. It has been a long time.

I think there has been an educational process that had to occur within the industry. The second thing is that you may be aware that one of the first approaches that the industry took was to suggest that utilities ought to be mandated to carry out this financial contribution, in an effort to make sure that there was an equitable distribution of participation. That took about a year's time to try to carry that out.

We have concluded that that is not the right way to go, and because of this conclusion, the voluntary program has been proposed. Of course, we all could have 20-20 hindsight and we would have started the voluntary approach a year ago.

In summary, the industry agrees with you that they should be making a contribution to TMI. We are undertaking such a voluntary program. While I cannot commit individual member companies of EEI, I think the results so far have been encouraging.

I think that is the end. Maybe the other gentlemen would like to add a word to that.

Mr. **Walker**. Just to follow up on this, isn't it true, though, that some member utility companies have turned you down flat; even people who are presently involved in nuclear generation have turned you down flat in terms of making contributions?

Mr. **Kearney**. I think it would be inappropriate of me to identify individual companies, but there is only one company with a nuclear program that has said that, and that is because of financing problems that it has with a particular unit. I would not say they turned us down flat. They said that they will continue to look at it.

The other thing that I think is encouraging is that the EEI Board recommended that the total industry make a contribution to this, not just the nuclear utilities, and I am very encouraged by the number of nonnuclear companies that are contributing to the program.

Mr. **Walker**. I thank you for that explanation. I think that is useful, and that is, I think, the kind of direction that we would hope we are going to achieve for the same purpose.

Mr. **Dubrow**. Mr. Walker, I am Morgan Dubrow with National Rural Electric.

I want to support Mr. Kearney's statement. Our people are going to participate in this voluntary effort. We certainly will support any kind of reasonable program which will get this job done.

Mr. **Taylor**. Congressman, you are quite right that there is a great storehouse of important information for the future of nuclear powerplants and there safer operation and more effective operation, up there at Three Mile Island.

The Electric Power Research Institute has a significant program today funded by the utilities to obtain that information, but this new program that Jack Kearney has mentioned will increase that effort enormously. EEI has enlisted our commitment to participate in this increased effort so as to assure that all the utilities in the country will get the benefit of this extremely important information.

We may, as a result of Three Mile Island, find—and we are working very hard on that now—that the deep concern many people have that there could be a reactor accident with loss of core cooling and loss of containment integrity would kill many people and cause great property damage may be unfounded. We may find as a result of following up from the Three Mile Island accident—where this did not happen—that this conclusion can be applied to all nuclear powerplants. That finding alone would be worth much more than is being talked about to be spent to clean up Three Mile Island.

Mr. **Walker**. I thank you for that observation. I think that is very true.

The problem, of course, is that because the funding has come so slowly, the insurance money is running out, and we now have talk of stretching out the time of the cleanup. We have been encouraged to hear that the cleanup may not cost as much as was originally calculated, but the stretchout of time, of course, is a health and safety issue with hundreds of thousands of people who live in the vicinity of it. I would simply urge that the quickest possible commitment of funding go in there because it is absolutely essential that the work continue and not be stalled for a lack of funding along the way.

Getting back to CRBR for a moment, my understanding is the Department of Energy is currently looking for some private financing to go into the project. Would any of you care to comment on how that search is going at the present time?

Mr. **Kearney**. I guess the only comment that I can make is one of ignorance. You are correct, the Congress has asked the Department of Energy to come up with some recommendations. I know that the Department of Energy is working with some representations of the utility industry and the financial community but not directly with the Edison Electric Institute.

We are, of course, obviously very interested in this, and I think that when the recommendations are made certainly the Edison Electric Institute will review them and comment.

Mr. **Walker**. As I understand it, they are going to report by about March 15, so we are getting down to the last couple of weeks of the search. You are saying that within that search, though, they really have not been talking to Edison Electric.

Mr. **Kearney**. No, sir, and I do not mean in any way to be critical of the Department of Energy for not doing that because I think they felt that probably the most efficient way was to look to some specialist in various areas, both in our industry and in the investment community, and come up with some recommendation. If they were to attempt to try to do that through the Edison Electric Institute, which has 180 member companies, it might be a little difficult, I think the DOE approach is the more effective and efficient way to do it.

Mr. **Walker**. As the Chairwoman mentioned, there are a number of us who are concerned about the whole matter of the budget, the whole issue of the economy as it relates to all of this. I think that I come at it from the standpoint that we are looking at projects within a concept of finite resources; that we have made some decisions in Congress, be they good or bad—and I tend to think they are good—to begin to limit the rate of Government growth. That has spread its way down through the entire budgetary process, which means that the research and development budget will not continue to grow at rates higher than inflation and, in fact, in many instances may be cut.

In that context, then you have to begin to look at specific projects within those finite resources. In the case of the Clinch River breeder reactor, we are talking about one project that absorbs 30 to 35 percent of all the money we have for energy research and development in the country.

Your testimony was articulate. You have given, I think, the case for Clinch River as a research and development project, but that still leads me to the question of, is it really something that over the next decade we can justify as 30 to 35 percent of everything we spend in the research and development area totally in energy?

Mr. YASINSKY. Congressman, within Westinghouse my responsibilities cover all advanced energy technologies, both nuclear and non-nuclear, so we have participated and we have studied them.

The criteria that we like to apply, which I think should be applied in evaluating the percentage of budget applied to various areas, is one of taking a look at the potential long-term benefits of an individual technology to the Nation. If we look at various nonbreeder reactor technologies, many of them have merit and should be developed, but many are restricted because of the need to be in a part of the country where we have significant sunshine or to be located in an area where we have constant wind or to be in an area where we have geothermal or availability of coal.

When we look at the breeder reactor for which Clinch River is the precursor, we see that we have a technology here that will permit us for centuries, and in fact thousands of years, to produce needed electricity with domestic resources, electricity made in America. As we have discussed many times, if we look simply today at the residual uranium tails that exist, already processed and stored at three locations in the United States, if those uranium tails, which are waste if not used in a breeder, if they are used in breeder reactors, they have the potential to produce fuel that would produce electricity that would be valued in the neighborhood of $40 trillion when compared with oil at $30 a barrel.

The point I am trying to make is we have here a technology represented by Clinch River that when you look at the potential benefits to the Nation far and away overshadow the other energy technologies. The others should be pursued but at funding levels and schedules consistent with the potential that they have to return benefits to the taxpayers.

Mr. WALKER. I guess I would have two comments on that.

No. 1, I think there is a tendency—and I have noticed a tendency in the course of the hearings over a couple years on this—to compare the breeder to solar and wind and some of those technologies. The fact is that this committee, in the totality of its research budget, also has to look at the kinds of technologies that make coal more efficient, that make the fission reactor more efficient. In other words, there are a number of research technologies that go to things far more than some of the alternative energies that do have some of the limitations that you refer to.

We are axing those programs as well in order to sustain this one program. That is, I think, a major concern.

Also, the other comment is if industry sees the breeder technology as having that kind of profitability over the long term, then it seems to me that there should be a lot more short-term interest in picking up a larger share of the R&D tab for putting the reactor into place in the first place.

Mr. YASINSKY. I have one brief comment on your last statement.

We are talking about an industry which, if successful, might be providing commercial power possibly 40 years from now. In the private sector, when a capital investment or an investment in research and development is made, it is standard practice to take a look at what product or service could result from that investment, when would it start producing revenues, and when profits start to be produced, if we present-value discount them back to today, how does that return on our investment compare with the cost of money today.

When you take $1 of profit in the year 2020 and present-value discount it today, you see that it is very difficult logically and from a private business point of view to justify significant investment. Independent of that, we do have a strong belief in the breeder at Westinghouse. We have made prior investments in facilities that are totally dedicated to the breeder technology, which have a present value today in the neighborhood of $100 million. We have, through our contractual arrangements, made contributions, and will continue to make contributions.

Within the context of what is prudent business, we will help and will continue to help.

Mr. Walker. Again, your analysis is right on target. I really do not disagree with anything you say, except that then that leads to the question of whether or not capital-intensive energy sources are going to be affordable in the future at all, regardless of what they are.

Your financial argument, it seems to me, raises then the question of how far we are willing to go on building heavily capital-intensive energy sources. I think that is one of the key questions that is being asked about standard nuclear fission plants at the present time, and to some extent it is being asked about coal plants at the present time. That I think is one of the key questions that we end up addressing.

Then from the R&D standpoint, when you come to this committee, we have to begin asking the question, if those kinds of financial constraints are in the capital-intensive field, shouldn't more R&D money be going toward the more non-capital-intensive energy sources, if that is what industry may have to turn to?

Mr. Yasinsky. Your response here is a little bit out of context with my previous answer to your previous question, because I am talking about investment today for a commercial industry that may be in existence 40 years from now. Your comment related to ordering today an existing capital-intensive plant, which, if load growth comes back, will still make sense.

Also, many of the other technologies that we have looked at, when you consider the capital cost in units of power or energy produced, are just as capital intensive, if not more capital intensive, than nuclear power.

Mr. Walker. Well, perhaps——

Mr. Yasinsky. The problem, I believe, is a generic one of determining how adequate financial return can be provided when investments are made to provide the generation capacity that is needed.

Mr. Walker. Perhaps, based on what we now know, but that is one of the key questions that we are supposed to be addressing here.

To go back to the financial argument for a moment, just a few moments ago you used $30 a barrel oil as a guideline. There is a possibility—we don't know what it may be, but there is a possibility—that we may be headed for $20 a barrel of oil. That changes an awful lot of financial questions with regard to a whole variety of energy sources, including nuclear, solar and a lot of the rest of them, where many of the judgments made by this committee were predicated on $4υ a barrel of oil.

Mr. **Yasinsky**. I have one last comment along those lines.

I think we have been criticized in the past for making projections, overly optimistic projections for future load growth and price of oil, clearly when it was understood that was a poor approach but at the time it looked good. However, to adopt a planning policy that assumes continual and permanent decrease in the price of oil would be just as wrong—and I think you have hit on one of the most difficult problems that we all face today. Given the turbulent economic situation and political situation in the world, how can we plan relative to future energy costs?

Mr. **Walker**. I have taken up more than my time.

However, to come full circle again, I come back to the problem that I face as a member of this committee in trying to determine priorities within finite resources of where we should put energy dollars. That specifically is the wall I come up against, too. That is why it becomes very difficult, then, to judge that one or two projects should absorb such a vast portion of all the money we have available, because all of those judgments have to enter into where we place our priorities here. One thing I have come to a conclusion on in the 7 years I have been on this committee is the fact that what we ought to be doing, at the very least, is developing a variety of energy alternatives out there, all of which the market can select from.

Therefore, I become concerned when we start talking about a large absorption by singular projects.

Your answer has been excellent. I thank you very much.

Thank you, Madam Chairman.

Mrs. **Bouquard**. Thank you very much, Mr. Walker.

In our budget last year, I felt the projections for nuclear were a little bit out of line; and this Member recommended cuts somewhere in the neighborhood of $30 million for the nuclear program and recommended that this money be spent on fossil and other forms of R&D energy research. I hope you will join me in this effort as well in this Congress.

Mr. **Walker**. Yes.

Mrs. **Bouquard**. I am very appreciative of the good crowd we have in this room today. I am sorry that we do not have a larger room. I want to thank all of you for being here.

However, I am going to ask you, because of the closeness of the room, that you refrain from smoking. Thank you very much.

Yesterday DOE testified that the direction of our breeder technology development program must be toward reducing plant cost where the breeder can be competitive of the LWR. Would you comment on this?

Would you like to comment on it, Dr. Richards, how these costs can be reduced?

Mr. **Richards**. In all nuclear technologies, including the water reactor technology, of course, there have always been strong efforts, and there has always been a need, to find cost reductions in the capital cost of the plant.

The work going on now, sponsored by the DOE with their COMO office in breeder technology, is going to give a strong focus on ways to reduce the capital cost of the breeder.

The breeder does have an advantage, of course, in the long term by virtue of putting a ceiling on fuel cycle costs. Therefore, there is a certain amount of increase in capital cost over and above that of a light water reactor, by virtue of the potential, the offsetting potential, of fuel cycle costs.

It has been thought since we started working on breeders that the breeder could sustain perhaps a 20- to 30-percent increase in capital cost over that of a comparable light water reactor. I think we are having difficulty with the technology in meeting that goal. Therefore, I think the next several years will be devoted to very substantial efforts at cost reducing the breeder. There are many, many good ideas that have come up through the participants in this program, and we think that the goal of attaining a differential in capital cost of 20 to 30 percent between a light water and a breeder is an attainable goal, but it will take work.

I might mention, of course, that we are going to get some ideas, as one always does, from demonstration projects such as Clinch River. When we put it all together and we run it, that, too, will give us I think good ideas on how to reduce costs in the future. That will be one of the tools I think that would be essential.

Mrs. **Bouquard**. John, do you want to comment on that?

Mr. **Yasinsky**. Thank you.

I agree with Dr. Richards' comments. One crucial point we have to understand is we are in a situation with Clinch River right now to demonstrate what, as I pointed out, is the most advanced design that exists today. Now the challenge we have ahead of us is to take a look at building from that experience base, building from the Clinch River experience base. As Dr. Richards indicated, there are several efforts under way, many being performed independent of DOE funding. General Electric has pursued these studies. We have pursued these studies. There are other organizations and laboratories pursuing such studies. This is commendable. It should be done, but one strong recommendation I would make is that since each of these design approaches to a follow-on plant would incorporate different approaches to reducing costs, what is essential is that all of these design and concept initiatives be coordinated and funneled through one organization; that there not be a situation which can be misinterpreted that people are proposing new plant designs that could, independent of Clinch River, succeed.

For that reason, I believe that the program that John Taylor described, the consolitated management office, is in an excellent position to take on the coordination of all of the advanced design work that is being done that would follow on and build from the experience of Clinch River once it is operating and would then be in a position to mold these ideas into a design that could follow on and, indeed, achieve overall economic parity in power production costs for breeder reactors in the future.

Mrs. **Bouquard**. Do you see COMO as a vehicle to move our technology development away from the Federal Government to the private sector? Do you see this possibility?

Mr. **Taylor**. It is a vehicle for that planning. Of course, it will take a very substantial time for that to actually occur.

I would like to add just a couple points on the cost issue. The most dependable base, of course, on which you can assess such a situation is when you actually have built something and then you know how much it costs. All projections, no matter what kind, are, unfortunately, uncertain.

Here I would look at the French experience because they have almost finished now a large, commercial-sized plant of 1,200 megawatts electric. They French believe that if they were to build another plant and could get the capital cost down 40 percent below what the Super Phoenix Plant, which is almost finished, is costing them, they will have achieved economic competitiveness with the light water systems. They are making their comparison with their pressurized water systems, which they are building at much lower costs than in the United States.

Mrs. **Bouquard**. The breeder would be about 20 percent more efficient than the LWR, wouldn't it?

Mr. **Taylor**. In other words, if the French can drop the cost they have actually experienced on Super Phoenix by 40 percent, they would be competitive with the present pressurized water reactors; that is, the incremental capital cost would be balanced out by the greater efficiency and the lower fuel costs in the breeder system.

We are fairly close, as I see it, to seeing the day that the breeder can achieve economic competitiveness. Again, they are comparing PWR's, which they are building over there at about half the cost it is taking us to build them. Therefore, their economic standards in that sense are even tighter.

Another point I would like to make is this: In the early days of light water nuclear power plants the nuclear steam supply systems [NSSS] were 50 percent of the capital cost. Today the nuclear steam supply systems are 10 to 15 percent of the capital cost of those plants. Most of the money is now going into concrete, into the lengthy time of construction, and, therefore, as interest to the bankers, and to a lot of things that are not uniquely dependent upon the specific nuclear system.

In the breeder we have a higher capital cost because the nuclear steam supply system is a more expensive system than in the light water systems. My guess is that the ratio NSSS cost to total cost of the breeder will reduce with further development because we are on a steep learning curve with the NSSS. We are not on a steep learning curve in building reinforced concrete structures, but those costs are something we must also address ourselves to, wherever they may exist, with whatever kind of nuclear powerplant.

Mrs. **Bouquard**. Thank you very much.

I did not finish my questions. However, inasmuch as our time is rather limited, I am going to thank you for being here and ask if you would respond to questions in writing for this committee, which will be made a part of the hearing record. We certainly would appreciate it.

Mrs. **Bouquard**. I also would like to add, in response to the Three Mile Island question, we will continue the subject of TMI in our converter reactor hearings on March 9 as well.

Thank you very much, gentlemen, for your knowledge and for your participation here today.

Our next panel of witnesses, whom we will welcome, includes Dr. Alvin Weinberg, who is with the Institute for Energy Analysis, Oak Ridge, and Mr. S. Jacob Scherr, of the Natural Resources Defense Council, who is representing the Taxpayers Coalition Against Clinch River.

We are happy to have both of you gentlemen with us today.

I am most happy to welcome a constituent of mine, a distinguished and honored scientist, Dr. Alvin Weinberg.

Dr. Weinberg has always enjoyed the sincere admiration of this committee. He is director of the Institute for Energy Analysis, which he was instrumental in establishing under the auspices of the Oak Ridge Associated Universities.

Dr. Weinberg's career dates back to the Manhattan project. From 1955 to 1973, he served as director of the Oak Ridge National Laboratory. In 1974 he was Director of the Office of Energy Research and Development in the Executive Office of the President.

He is considered to be one of the Nation's foremost authorities on nuclear energy. He was the originator of the pressurized water reactor and has published many papers on reactor physics.

For his role in the development of nuclear reactors, Dr. Weinberg shared the Atoms for Peace Award in 1960 and was one of the first recipients of the E. O. Lawrence Memorial Award. He holds many other awards and has been honored both here and abroad for his extensive contributions to science and the development of nuclear power.

Clearly, there is no more qualified individual to speak on the subject at hand.

Dr. Weinberg, we are, indeed, fortunate to have you with us today.

You may proceed with your testimony.

STATEMENT OF ALVIN WEINBERG, INSTITUTE FOR ENERGY ANALYSIS, OAK RIDGE, TENN.

Dr. **Weinberg**. Let me say that I am very grateful, Madam Chairman, for this opportunity to express my views on the breeder program, and particularly I am grateful for the opportunity to testify before my own Congresswoman. I do not think I have had that opportunity before, and I appreciate it very much.

I should explain that, as perhaps suggested by your list of things that I have done in my past, that I am really not in the mainstream of nuclear development at present. I am sort of elderly, if you like. Therefore, I am not as close to the details of the current program, particularly the support program in LMFBR, as I was when I was the director of the Oak Ridge National Laboratory. Therefore, I will confine my remarks to rather general observations about the program, and perhaps bring in some, shall we say, ancient history that I do not think has been fully appreciated by all those who are involved in making decisions about this very important program.

First, I would like to speak to this question of the role of the breeder in overall nuclear and energy strategy and remind the committee that the breeder is, in fact, an inexhaustible energy source. This realization came to us really not until about the mid-1950's, although even during the war—that's World War II—we thought about this to some degree. It was only in the 1950's that we actually made calculations as to what would be involved in extracting, say, the uranium from the Chattanooga shales or thorium from the New Hampshire granite or, indeed, the uranium from the sea, and could you, in fact, make an energy system involving the breeder based on that source of raw material.

Much to our surprise and delight, we concluded that, yes, this was possible. At that time I referred to the breeder as a means of "burning the rocks": Take the uranium out of the granitic rocks and burn it in a breeder. I contrasted this with the fusion process, which is also an inexhaustible energy source, and which I referred to as "burning the seas." Achievement of "burning the rocks" and "burning the seas," which are the two ways of getting inexhaustible energy from nuclear energy, as far as we know—these were the twin Holy Grails of nuclear energy since the early 1950's.

We recognized at that time that if we could achieve this, then we would be well on our way to achieving what H. G. Wells in his book written in 1914 spoke of as, "Setting the World Free." He wrote a book called, "Set the World Free," which visualized a world in which mankind had a nuclear, and relatively cheap, source of energy which would be inexhaustible.

All of us did recognize at this time that the breeder was a long-term solution to man's energy problem, but we always understood, even in those early days, that we could not state exactly when the breeder would be needed, because that was an economic question.

We are aware, as members of the previous panel pointed out, that the breeder is turning out to be more expensive than we had hoped and that, unless the breeder becomes considerably less expensive than it now seems to be, there will be no very great incentive to deploy breeders on economic grounds. In this respect, I agree completely with people who dislike breeders. We will not have breeders unless they turn out to be economical.

This committee must recognize, and the public must recognize, that we are applying a double or even a triple standard to the breeder program as compared to the other two inexhaustible energy sources. We do not seem to be asking whether solar energy or fusion energy are economical. Fusion and solar energy like the breeder are inexhaustible; neither of them is economical.

Therefore, one of the main burdens of my testimony is that I think we must view the breeder in the same way and from the same perspective as we do the competitive inexhaustible energy sources. It is not quite fair to demand an economic, a short-term economic payoff from the breeder without at the same time demanding that same short-term economic payoff from the other inexhaustible energy sources.

There are, of course, secondary advantages to the breeder.

It is often not stressed sufficiently strongly that the breeder would require essentially no mining of uranium for a very long time, and eventually very much less mining of uranium than we now demand. Therefore, the disposal of mill tailing would not be a problem if you had the breeder.

Let me make a few comments about my reactions to the foreign program. I recently spent a week in France visiting several of the large nuclear energy plants that are strung along the Rhone River between Lyon and Marseilles. For one who was involved in the Manhattan project before the first chain reaction had been established, actually seeing these multiunit stations at Bugey or Tricastin or Marcoule, routinely sending out as much as 4,000 megawatts apiece of electricity really blew my mind.

As all of us know, France has steadfastly followed what I consider to be the most sensible energy program, energy posture, in the whole world. It is moving aggressively to electrifying the country with nuclear electricity.

Electrifying means that it cuts back on oil. Nuclear electricity—and this is a point that should be remembered—means that France, although it will be producing more energy in 1990 and 2000 than it is producing now, will be the one country in the world that will be sending less carbon dioxide into the atmosphere at that time than it is sending out now.

Then I returned to the United States where nuclear energy is being strangled in an atmosphere which I can only describe as antitechnological arrogance. Rather than thank our technologists for demonstrating that man can now look forward to a future unconstrained by a shortage of energy, our coercive utopians, to use the word that was coined by Peter Metzger, attack the U.S. program of breeder development and cry for an end to the one remaining breeder project, which is the Clinch River breeder.

I can only say that I agree very strongly that insofar as possible the breeder program ought to be internationalized. I think it would be great if we could make agreements with France, with Japan, with England. I think it would be greater still if the Department of Energy would give very positive encouragement to this. I would hope that the committee can find out from the Department of Energy how much encouragement it is giving to such possibilities for internationalizing.

Let me turn to my final point, which I call "Why Clinch River?" This is really the essence of what I have to say, and then I will keep quiet.

We are now in the throes of a nuclear moratorium. Why, then, do I believe that we should build the Clinch River breeder? The essential point is one that was contained in Mr. Yasinsky's written testimony but he did not mention it in his oral testimony. It has to do with the necessity for making a distinction between what I call "energy strategy" and "energy tactics."

By "strategy," I mean the overall policies that govern the long-term development of our energy future. By "tactics," I mean the short-term decisions that implement this overall strategy.

I think our failure to distinguish between strategy and tactics has confused the debate over Clinch River.

I already have pointed out that we have three potential inexhaustible energy sources: solar in all of its manifestations, fusion, and the breeder. When we really shall need any of these inexhaustibles is hard to say. It may be 50, it may be even 100 years from now. Yet, every administration since President Truman's has accepted as national policy the necessity of investigating these long-range energy sources, including the breeder, and has committed many millions of dollars to these efforts. I do not fully agree with the way the money has been allocated. For example, when I was in Washington as head of the Office of Energy Research and Development, I was very strongly in favor of increasing the amount of money that was being spent on solar energy, and I continue to be in favor of spending as much money as we can on solar energy.

At present, more than $1 billion is being spent on developing these various inexhaustible energy sources. I include in this what is being spent on the LMFBR, what is being spent on fusion, what is being spent on renewables.

President Jimmy Carter accepted the necessity of pursuing breeders, even though he rejected Clinch River.

Now, as Mr. Yasinsky suggested, you can adopt various tactics for achieving the strategic goal of a successful breeder. An alternative tactic to building Clinch River would focus very much strongly on testing components, the base technology program, rather than building an operating breeder. This course seems to be advanced both by those of the Clinch River opponents who accept the long-range strategic goals of breeders but disagree with the tactic of building Clinch River, and also by those whom I can only describe as the nuclear nihilists, who see killing Clinch River as a step to killing nuclear energy.

My own 40 years of experience in nuclear energy make me agree very much with the position described by Mr. Yasinsky, that the least effective way to do heavy engineering development is to spend too much effort on component testing without focusing on a fully integrated operating device in which the real problems reveal themselves.

One reason we are so far behind the other countries is that some dozen years ago we made the incorrect decision of focusing on components too heavily, and we did not get around to doing Clinch River seriously until an awful lot of time was wasted. The result is that we lost 10 years and suffered tremendous cost escalation.

By choosing the wrong tactics in developing the breeder, namely, not really focusing precisely and predominantly on the reactor, we have lost an awful lot of time.

The second reason has to do with time scale. I have often felt, and I have often said in some of my remarks—and some of you may realize that I am sometimes regarded within the nuclear community as an in-house Cassandra of nuclear energy—I have often felt that we may have gone too fast on our conventional light water deployment.

We forget that a thousand megawatt powerplant, if it is to be fully economical, is expected to last as long as 30, maybe even 40, years. I point out that we do not really know how long these things are going to last.

James Watt's steam engine, one of his first ones, ran until 1907, about 150 years. These things, when you build them, you expect to last a very, very long time.

However, if we build reactors too quickly, we have no way of knowing whether the system will last anywhere near 30 or 40 years, nor can we incorporate lessons learned in earlier reactors into later ones without expensive backfits. That seems to be happening with many light water reactors. Steam generators and pipe cracking may limit their lifetime, even though we have learned ways of dealing with these problems in new reactors.

I think that not having the time to go seriatum but compressing the sequential development has been responsible for at least some of the travail that we have experienced in the light water business.

Can we not learn from this experience? If we have 50 or 60 or 70 years even before breeders are needed on a large scale, you do not have all that much time to wait. If Clinch River is built by 1990, it will be 2020 before we know whether the device has lasted 30 years or whether serious deficiencies that appear after extended operation will limit the lifetime.

I would therefore like to respond to Mr Walker's question: Does it make sense to spend as much as 30 percent of our energy budget on the entire LMFBR program, both the Clinch River breeder and the support program, which comes to about $640 million, or one-third of the total energy R&D budget?

I would turn the question around and say, if you concede that the development of a breeder continues to be a valid national policy, something that every President since President Truman has revalidated, then it is a question of what are the best tactics to arrive at a successful breeder.

If one feels that $602 million is too much to spend on the breeder program, and that of course is a question of overall tactics, comparing breeders versus the other inexhaustibles, one must look further and ask, within that $602 million, should one use the money to finish the breeder or use the money for longer range, rather general development.

My own instinct, which is reinforced by the 40 years' experience that I had in heavy engineering development, is that you waste money in heavy engineering development unless you focus on a device that is integrated, and that reveals the real problems.

We are unaccustomed to think about technologies that are as slow moving and ponderous as are large nuclear power plants. In this age of computers and jet travel, time is foreshortened, and we forget that only with the passage of 30 years will we know that a bid device will last for 30 years.

We do not have time to waste, and we ought, therefore, to get on with Clinch River. The great French Marshal Lyautey once said to his gardener, "Plant a seedling tomorrow." And the gardener said, "It won't bear fruit for a hundred years." "In that case," Lyautey said to the gardener, "plant it this afternoon." Clinch River is such a seedling.

Thank you very much.

[The prepared statement of Dr. Alvin Weinberg follows:]

TESTIMONY ON THE BREEDER PROGRAM*

Alvin M. Weinberg
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I am grateful for this opportunity to express my views on the breeder program. I am not as close to the details of the current program, particularly the support program, as I was when I was director of the Oak Ridge National Laboratory. I shall therefore confine my remarks to three topics:

(A) The role of the breeder in overall nuclear and energy strategy;

(B) The U.S. breeder development relative to foreign programs, particularly the French; and

(C) Why Clinch River?

A. The Role of the Breeder in Overall Nuclear and Energy Strategy

That the breeder is an essentially inexhaustible source of energy--like the sun or fusion--is still not fully appreciated by the public. We realized even during the Manhattan Project that the breeder enables one to burn perhaps 60 percent of all the uranium (as well as thorium) dug from the ground. That the fissile uranium U-235 represents about 0.7 percent of natural uranium had led many to the mistaken observation that, therefore, the breeder would extend our nuclear energy resource by the ratio of 60 to 0.7--about one hundredfold.

This, of course, grossly underestimates the potential of the breeder. Because it burns uranium so efficiently, the breeder in principle can exploit far lower grades of uranium than can the ordinary burner--for example, even if uranium cost, say, $500 per pound, the cost per kilowatt-hour of the raw fuel would still be very small. Moreover, at costs as high as this, the uranium and thorium exploitable, in the sea or in many common rocks, could supply mankind with energy for many thousands, and even millions, of years.

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*Presented before the Subcommittee on Energy Research and Production, U.S. House of Representatives Committee on Science and Technology, Washington, D.C., February 23, 1983.

This realization as to the full significance of the breeder came to the consciousness of the nuclear community about 25 years ago. I referred to nuclear breeding then as "burning the rocks"--i.e., burning the vast amounts of residual uranium in the granites; by contrast, I called fusion "burning the seas," since the deuterium used in fusion is abundant in sea water. Thus ever since the late 1950s, the nuclear community has recognized that the breeder, no less than thermonuclear fusion, or the sun, represents an inexhaustible energy source. Development of a cheap breeder, no less than development of a cheap fusion reactor, or a cheap solar energy system, would, to paraphrase H. G. Wells, "Set the World Free."

Though all recognized the breeder as being a long-term solution to man's energy problem, questions have always been raised as to when a commercial breeder would be needed. This is a matter of economics. We had originally hoped that the breeder would cost no more to build than a conventional Light Water Reactor. Unfortunately this does not seem to be the case now; the economic break-even cost of a breeder will depend upon the cost of uranium that is used in an LWR. Very roughly, the increment in cost per pound of uranium at which power from an LWR is as cheap as power from a breeder is about 0.4 times the increment in capital cost of the breeder per kilowatt. Thus if a breeder cost, say, $500 per kW(e) more than an LWR, the cost of uranium would have to rise by $200 per pound before such LWRs would be displaced by breeders, on strictly economic grounds.

This, of course, is the basic economic argument against deployment, or even serious development of the breeder. I believe this argument is deficient in several respects.

First, when we invoke this argument against serious development of breeders but do not invoke comparable arguments against serious development of the other inexhaustible energy systems, solar and fusion, we are being very inconsistent. Neither of the other two inexhaustibles appears to be competitive with electricity from an LWR, yet this has not deterred us from going ahead with serious work on these alternatives.

Second, the capital cost of the breeder seems to be very high now--yet there are few inherent reasons why this should always be the case. In short, serious continued development ought to result in a cheaper breeder.

Third, the breeder requires very little mining of uranium. Insofar as one regards the handling of mine wastes and mill tailings as important environmental deficiencies of the current reactors, one largely avoids this set of problems by using breeders.

Finally, I shall comment on objections to the breeder based on fears of proliferation and the "plutonium economy." To these fears one must say simply that we are not speaking of widespread deployment of reprocessing facilities outside the United States. We are dealing with a technology that, for a long, long time, would be available only to those states such as the United States, Western Europe, Japan, and the Soviet Union, that either already possess nuclear weapons, or have the capacity, should they choose, to develop their own weapons. Thus the argument against breeders based on concern over proliferation has always seemed to me to be without merit.

B. The U.S. Breeder Development Relative to Foreign Programs, Particularly the French.

I recently spent a week in France visiting several of the half-dozen large nuclear power plants strung along the Rhone River from Marseilles to Lyon. For one who was involved in the Manhattan Project before the first chain reaction had been established, actually seeing the multi-unit stations at Bugey or Tricastin or Marcoule, routinely sending out as much as 4 million kilowatts made a powerful impression.

France has followed steadfastly the most rational energy policy in the West: large-scale replacement of oil by electricity generated from uranium or coal, which are not subject to OPEC's whims. By 1990 France expects to use only 73 million tons of oil, compared to the 108 million tons it used in 1978. Key to this strategy is the widespread use of nuclear electricity. By 1990, some 30 percent of all primary French energy will be nuclear.

Extraordinary as this French initiative is, the French breeder program, represented by Phenix and Super-Phenix, is even more impressive. Phenix has been producing 250 megawatts of electricity routinely since 1973. For the last few years, the plutonium burned in Phenix is the same plutonium bred in the reactor as a by-product of its power production. The only fuel required for Phenix is therefore ordinary uranium, or even uranium depleted in U-235.

Phenix demonstrates nuclear energy's holy grail: a practical, inexhaustible energy source based on the breeder. To be sure, power from Phenix or from Super-Phenix costs perhaps twice as much as power from conventional reactors or from coal. Yet, considered in perspective, Phenix is a remarkable achievement. And, in the long run, as construction is standardized and interest rates fall, one can expect the cost of breeders to fall. We would then have an inexhaustible energy source at a price not very different from what we now pay for electricity from coal or uranium.

How frustrating then to return to the United States, where nuclear energy is being strangled in an atmosphere of anti-technological arrogance. Rather than thank our technologists for demonstrating that man can now look forward to a future unconstrained by a shortage of energy, our Coercive Utopians (to borrow Peter Metzger's phrase) attack the U.S. program of breeder development, and cry for an end to the one remaining U.S. breeder project--the Clinch River Breeder.

In view of the manifest lead held by France, I believe the United States can profit by entering into cooperative arrangements with France and other countries for development of breeders. I say this with dismay since we were far ahead of the world in breeder development in the 1960s. We lost our lead, as much as anything, because our entire effort was too heavily fragmented, lacked continuity, and, above all, has lacked political commitment.

As a practical matter, I would urge that the next step in breeder development be much more heavily internationalized than are the current steps. I am unprepared to say exactly what these steps should be, except to insist that strong international cooperation, even to joint funding of a new demonstration plant or plants ought to be given serious consideration.

C. Why Clinch River?

At this moment, we are in the throes of a nuclear moratorium--no new reactor has been ordered in the U.S. since 1978, and it is unlikely that a new one will be ordered in this decade. Why, then, do I believe that we should build the Clinch River Breeder?

We must distinguish between energy strategy and energy tactics. By energy "strategy" I mean the overall policies that govern the long-term development of our energy future; by energy "tactics" I mean the short-term decisions that implement the overall strategy. Our failure to distinguish between strategy and tactics has confused the debate over Clinch River.

Since fossil fuels are limited, either because they may be exhausted, or because their environmental impact may be unacceptable, our government has always accepted as a cornerstone of energy policy the development of the inexhaustible energy sources: solar energy in all its manifestations (wind, hydro, direct solar, biomass); thermonuclear fusion; and the breeder. When we shall need any of the inexhaustibles is hard to say--it may well be as much as 50 or even 100 years from now. But every administration, since President Truman's, has accepted as national policy the necessity of investigating these long-range energy sources including the breeder, and has committed many millions of dollars to them; at present more than a billion dollars is being spent on developing these inexhaustible energy sources. Even President Jimmy Carter accepted the necessity of pursuing breeders, though he rejected Clinch River.

Various tactics can be adopted for achieving the strategic goal of a successful breeder. An alternative tactic to building Clinch River would focus on testing components rather than building an operating breeder. This course is being advanced both by those of the Clinch River opponents who accept the long-range strategic goal of breeders, and by the nuclear nihilists who see killing Clinch River as a step to killing nuclear energy. My own 40 years of experience in nuclear energy has shown over and over that the least effective way to do heavy engineering development is to spend too much effort on components without focusing on a fully integrated operating device in which the real problems reveal themselves. One reason other countries are so far ahead of the United States in breeder development is that they built operating reactors, while we fiddled with components. Clinch River is our first fully integrated large-scale breeder--it represents a shift in research tactics from never-ending development of components to the building of an integrated device that will exhibit the true problems and possibilities. I can only say we lost 10 years, and suffered tremendous cost escalation, by choosing the wrong tactics in developing the breeder.

The second reason for building Clinch River has to do with time scale. I often have felt that we went too fast in our conventional Light Water Reactor deployment, that much of nuclear energy's travail would have been avoided had we moved more deliberately. We forget that a 1000 MWe power plant, if it is to be fully economical, is expected to last as long as 30 years; but if we build reactors too quickly we have no way of knowing whether the system will last anywhere near 30 years, nor can we incorporate lessons learned in earlier reactors into later ones without expensive backfits. This is now happening with many Light Water Reactors--steam generators and pipe cracking may limit their lifetime, even though we have learned ways of dealing with these problems in new reactors.

Can we not learn from this experience? If we have 50 years before breeders are needed on a large scale, we do not have all that much time to wait. If Clinch River is built by 1990, it will be 2020 before we know whether the device has lasted 30 years--or whether serious deficiencies, that appear after extended operation, will limit its lifetime.

We are unaccustomed to think about technologies that are as slow-moving and ponderous as are large nuclear power plants. In this age of computers and jet travel, time is foreshortened, and we forget that only with the passage of 30 years will we know that a big device will last for 30 years. We do not have time to waste--we ought therefore to get on with Clinch River. The great French Marshal Lyautey once said to his gardener: "Plant a seedling tomorrow." And the gardener said, "It won't bear fruit for a hundred years." "In that case," Lyautey said to the gardener, "plant it this afternoon." Clinch River is such a seedling.

Mrs. **Bouquard**. Thank you very much, Dr. Weinberg.

We will submit questions to both of you as a panel.

We will now hear from Mr. Jacob Scherr. He is accompanied by Ms. Jill Lancelot-Greenbaum.

We welcome both of you and look forward to your testimony at this time.

STATEMENT OF S. JACOB SCHERR, SENIOR STAFF ATTORNEY, NATURAL RESOURCES DEFENSE COUNCIL, REPRESENTING THE TAXPAYERS COALITION AGAINST CLINCH RIVER, ACCOMPANIED BY JILL LANCELOT-GREENBAUM, DIRECTOR, CONGRESSIONAL AFFAIRS, NATIONAL TAXPAYERS UNION

Mr. **Scherr**. Thank you, Madam Chairman and members of the committee.

I am Jacob Scherr. I am a senior staff attorney with the Natural Resources Defense Council. I am accompanied today by Jill Lancelot-Greenbaum, who is the director of congressional affairs for the National Taxpayers Union. We are appearing today on behalf of the Taxpayers Coalition Against Clinch River regarding continued Federal funding for the Clinch River breeder reactor.

The coalition is made up of 16 member organizations representing millions of American citizens. It is a uniquely diverse coalition of taxpayer, fiscal conservative, labor, consumer, environmental, scientific, and church groups. The member organizations differ in their attitudes toward nuclear power. They vary in their views as to the proper role of the Federal Government in the development and demonstration of new energy resources. However, they joined together last spring to provide the facts to the American public and their elected representatives regarding the enormous and unnecessary waste of taxpayers' money on the Clinch River breeder reactor project.

Over the course of the last year a number of other respected institutions and opinion leaders have reached the same conclusion; that is, that further Federal investment in the CRBR is economically unjustified. These include the Heritage Foundation, the Federation of American Scientists, the Wall Street Journal, the League of Women Voters, Readers Digest, National Review, and analysts from the American Enterprise Institute, Hoover Institution, and the Rand Corp.

I brought with me today a list of editorials and articles from newspapers and periodicals across this country in opposition to Clinch River. I have also brought a brief compendium that we prepared of statements from scientists, economists, and other experts regarding Clinch River. With the permission of the chairman, I would like to submit these for inclusion in the record.

Mrs. **Bouquard**. Without objection, they will be made part of the record.

Mr. **Scherr**. Thank you.

[Material follows:]

NEWSPAPERS ACROSS THE COUNTRY SPEAK OUT AGAINST THE CLINCH RIVER BREEDER REACTOR

ALABAMA	"Clinch River," Times-Daily, Florence, 9/4/82
ARKANSAS	"A House Vote on the Breeder," Arkansas Gazette, Litte Rock, 12/16/82
	"A Close Vote on the Breeder," Arkansas Gazette, Little Rock, 10/1/82
	"Funding a Plutonium Factory," Arkansas Gazette, Little Rock, 9/27/82
	"New Resistance to Clinch River," Arkansas Gazette, Little Rock, 6/23/82
CALIFORNIA	"Breeder Reactor in the Clinch," Sacramento Bee, 12/22/82
	"Nuclear 'Turkey' on Congress' Menu," Los Angeles Times, 8/22/82
	"The Breeding of a Failing Grade," Los Angeles Times, 7/11/82
	"Clinch River: pork barrel breeder," Contra Costa Times, Walnut Creek, 7/9/82
	"$6 Billion Pork Barrel," Sacramento Bee, 7/22/81
	"The Breeding of a Bad Bargain," Los Angeles Times, 5/10/81
COLORADO	"Breeding a bad bargain," Sentinel, Grand Junction, 8/1/82
CONNECTICUT	"Stop the Clinch River folly," Bulletin, Norwich, 12/9/82
	"Breeder Boondoggle funded again," News-Times, Danbury, 10/9/82
	"A Reactor Breeding Waste," Hartford Courant, Hartford, 10/2/82
	"Last Straw for the Breeder," Hartford Courant, Hartford, 9/22/82

"No Need for the Breeder," Hartford Courant, 8/18/82

"Breeding Waste," The Herald, Central Connecticut, 8/11/82

"Stop Clinch River Boondoggle," News-Times, Danbury, 7/31/82

DISTRICT OF COLUMBIA

"That clinches it," Washington Times, 12/14/82

"A Chance to Kill the Breeder," Washington Post, 12/2/82

"Friends of Plutonium," Washington Post, 11/19/82

"Monumental Blunders," Washington Post, 10/3/82

"Plutonium Pork Barrel," Washington Times, 9/27/82

"Clinch River Revival," Washington Post, 7/6/82

"Class Act at the N.R.C.," Washington Post, 5/20/82

"Three That Deserve to Lose," Washington Post, 7/21/81

"Breeder Reactors: Fact and Fable," Washington Post, 4/28/80

FLORIDA

"Cut off funding now for breeder reactor," News-Press, Fort Myers, 12/11/82

"Shooting a Tough Turkey," Sun, Gainesville, 12/9/82

"If Congress wants to save," St. Petersburg Times, 12/2/82

"Pork Barrel lives in Clinch River," Fort Lauderdale News, 8/19/82

"The Clincher," The Miami Herald, 8/17/82

"All this project breeds is more cost overruns," Today, Cocoa, 6/19/82

ILLINOIS

"Dump the Clinch Breeder," Chicago Tribune, 12/13/82

"Kill the Clinch River Monster," Sun-Times, Chicago, 12/2/82

"Ax this nuclear turkey," Sun-Times, Chicago, 9/2/82

	"The High Cost of Howard Baker," Chicago Tribune, 11/7/81
INDIANA	"Reactor Project is a Waste," Star, Terre Haute, 7/7/81
IOWA	"Why Clinch River?" Burlington Hawkeye, 12/20/82
	"As far as it should go," Quad City Times, Davenport, 9/23/82
	"Clinch River vote," The Daily Iowan, Iowa City, 7/28/82
KANSAS	"Clinch River's Days are Numbered," Eagle & Beacon, Wichita, 10/4/82
KENTUCKY	"Changing times and the breeder," Sun-Democrat, Paducah, 12/16/82
	"Another chance to end Clinch River boondoggle," Courier-Journal, Louisville, 12/7/82
	"Pentagon can't be spared when cutting budget waste, Courier Journal, Louisville, 8/27/82
	"Nuke loser--Clinch River's all wet," Times, Louisville, 8/9/82
	"Cut Waste? It's easy to do: just scrap breeder reactor," Courier-Journal, Louisville, 7/29/82
MARYLAND	"Good Money After Bad," Hagerstown Mail, 1/10/83
	"$10 billion pork barrel," News-American, Baltimore, 12/6/82
	"Clinch River Stays Alive," The Baltimore Sun, 10/2/82
MASSACHUSETTS	"The case against Clinch River," Christian Science Monitor, Boston, 12/17/82
	"Plugging a cash rat hole," Boston Globe, 12/2/82
	"A vote on Clinch River," The Boston Globe, 9/21/82
MICHIGAN	"Clinch River: Why throw precious funds away on an insatiable monster?" The Detroit Free Press, 7/19/82
MINNESOTA	"Breeder Survives," Pioneer Press, St. Paul, 10/4/82

MISSOURI	"Danforth Votes for a Boondoggle," St. Louis Post-Dispatch, St. Louis and Daily Dunklin Democrat, Kennett, 10/28/82
	"Clinch River still a long way off," The Kansas City Star, 8/11/82
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THE NATIONAL PRESS COVERS CLINCH: ARTICLES AND EDITORIALS TAKE A CRITICAL VIEW

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Experts Speak Out Against the Clinch River Breeder Reactor*

"The Energy Research Advisory Board believes that the construction of a breeder reactor demonstration at this time is not an urgent priority and thus under current budget constraints, recommends that such a demonstration be delayed until a future time."

-- Energy Research Advisory Board,
Department of Energy, November
1981

"...It seems to me ironic that the federal government is now pushing ahead with the Clinch River demonstration breeder reactor at a time when a disabled light water reactor immediately threatens the future of the light water reactor industry. There will be no market for breeder reactors unless there is a prolonged period of expansion in the market for light water reactors. If the Reagan administration intends to revive and maintain a viable nuclear power option in the United States, the Three Mile Island cleanup should have, in the near term, a higher priority in the use of scarce government funds than breeder reactor development."

--Mason Willrich
Vice-President for Corporate
Planning, Pacific Gas and
Electric Company speaking to
the Uranium Institute,
September 1981

"All the economic evidence seems to point in the same direction: it won't make sense to build commercial breeders until well into the next century at least. The reluctance of utilities to shoulder the full cost of the project should tip us off that it's a money loser. Projects like this are a millstone dragging down the nuclear industry."

-- Walter Olsen
Associate Editor, Regulation
Magazine, American Enterprise
Institute

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*The views presented here are those of individual experts and not necessarily the institutions with which they are affiliated.

"...In some respects the best way to kill the U.S. nuclear program is to keep Clinch River alive. It will be the subject of controversy year after year until it is built. That's approximately ten more years. Do we want to prolong this controversy, will this controversy be beneficial to the nuclear industry? That is the major question which the nuclear industry and the Department of Energy should ask of itself."

-- Arnold Kramish
Former Manhattan Project nuclear physicist; former Assistant to the Manager, Atomic Energy Commission; Member of the National Planning Association's Breeder Board

"Nuclear power offers the nation a benign, safe, non-polluting and economical method of generating electricity. The Clinch River Breeder Reactor, however, would be an expensive, inefficient project that would waste the taxpayers' dollars. In a period of low and falling uranium prices, breeder reactors are unwarranted and the Clinch River project is a particularly poor public investment."

-- Thomas Moore
Director of Domestic Studies and Senior Fellow, Hoover Institution, Stanford University

"The breeder produces more fuel (in the form of plutonium) than it consumes, and in principal offers up to a one hundred-fold increase in the utilization efficiency of uranium. It is thus seen as the logical replacement for light-water-reactors once low-cost uranium resources have been depleted. But even the strongest proponents of the breeder do not claim it can solve the industry's current problems. Indeed, unless those problems are solved, the case for the breeder breaks down."

-- Richard K. Lester
Associate Professor of Nuclear Engineering, Massachusetts Institute of Technology

"Nuclear energy is too important to the nation's future to allow it to be discredited by the Clinch River Project."

-- Gordon Jones
Energy and Environment Foundation, former energy analyst, Senate Republican Policy Committee and Energy Task Force Director of the 1980 Republican Platform Committee.

"In the jargon of cost-benefit analysis, the fast breeder is a technology of excessive costs and minimal benefits: even given its possible returns, the liquid metal fast breeder reactor's developmental expenses are too great, its alternatives too available, and a plutonium economy too threatening. Clinch River represents a Faustian bargain almost too embarassing to pose let alone accept."

-- Peter DeLeon
Senior Social Scientist
Rand Corporation

"Given the trend towards reduced growth in demand for electricity in the United States, the progress being made in alternative and renewable energy resources, new oil and gas discoveries, cleaner and more efficient technologies for coal use, and the present uranium glut, the fast breeder reactor is an option the U.S. will not need in this century, and may not need in the next...Unnecessary early development will only heighten public criticism while contributing nothing to the energy security of the U.S. If and when the breeder is needed here, the technology will have so changed that Clinch River will be little more than a quaint and expensive relic."

-- Gene Rochlin
Research Policy Analyst at the Institute of Government Studies and Lecturer in Energy and Resources,University of California, Berkeley

"...Clinch River's price tag has ballooned from $699 million to over $3.3 billion (sic), with more cost overruns in sight...other nations were moving rapidly ahead to develop their own breeder reactor technology. Even they, however, are finding that the cost is considerably above what had been expected, and, as a result, the technology is not quite as attractive as they once believed. To a large degree, the breeder has become something of a technological status symbol. Though $3.3 billion seems a bit much to spend for status...."

-- Milton Copulos
Director of Energy Studies
The Heritage Foundation

"Since the breeder is not expected to be economical until after the year 2040 it is far too early to build a demonstrator now. Moreover, taxpayers will be asked to support prematurely not only the Clinch River Breeder Reactor but also its required fuel cycle facilities. The total additional cost will be much higher than the often mentioned figure of $2.3 billion...."

-- Brian G. Chow
Senior Research Specialist,
Pan Heuristics, R & D
Associates

"The tragedy of the nuclear power industry is its reliance on the political process rather than the market for guidance...The Clinch River Project reveals how far afield an industry can wander when economic reality is replaced by political caprice.

-- Richard W. Wilcke
President, Council for a
Competitive Economy

"A poll of the Federation of American Scientists Council and its concerned sponsors has revealed a consensus that, regardless of whether fission power is needed for the long-term, there is no need at this time for the U.S. government to commit itself to commercialization of breeder reactor technologies and, therefore, to build the demonstration Clinch River Breeder Reactor (CRBR)...."

-- Frank von Hippel
Chairman, Federation of
American Scientists and Senior
Research Physicist, Center for
Energy and Environmental
Studies, Princeton University

"I do not support the completion of the CRBR or the deployment of commercial breeder reactors now... Specifically, I would disagree with the argument that one must build the breeder reactor in order to avoid the loss of technical expertise (and enthusiasm) of a whole generation of reactor engineers. Nonsense!"

-- Richard L. Garwin
Adjunct Professor of Physics,
Columbia University

Reflecting what we view as a broad consensus regarding Clinch River, the House of Representatives decided last December to terminate Clinch River funding in fiscal year 1983. In our view, the task now before this committee should not be attempting to keep this floundering pork barrel alive, particularly at a time when the Federal deficits are approaching $200 billion. Rather, the committee should move to deauthorize the Clinch River breeder reactor and to reorient our breeder research and development efforts based upon the economic energy realities of the 1980's.

The Clinch River breeder reactor project was authorized over a decade ago to demonstrate the commercial viability of breeder reactors in a utility environment. I think it is important to emphasize that this is not a research and development project. The Clinch River breeder reactor is being licensed by the Nuclear Regulatory Commission, as would any commercial nuclear power plant.

As David Stockman pointed out very eloquently in 1977:

> The breeder reactor is not the mythical cornucopia of boundless, free energy supplies. It is a commercial process designed to reduce the cost of nuclear generated electricity by substituting capital investment in plant for purchase of a raw material—uranium.

The decision over 10 years ago to proceed with the commercial demonstration of breeder reactor technology was based upon economic analyses which showed that breeders would become economically competitive with light water reactors in the near term as the price of uranium soared. These analyses, which were dubious at the time, are now severely out of date, and I think that even most breeder proponents would agree that these analyses have now entered the realm of fantasy.

It was assumed that the 7-percent annual electric power growth rate which prevailed in the United States in the 1960's would continue unabated. Instead, this growth rate has dropped well below 3 percent.

It was assumed that the frantic pace at which utilities were ordering nuclear powerplants would continue. It was projected that there would be 1,000 nuclear powerplants in the United States by the year 2000, of which some 200 would be breeder reactors. Instead, there have been no new nuclear powerplants ordered in this country during the past 5 years, and since 1975 almost 80 orders have been canceled. Now DOE is projecting that there will be only some 160 nuclear power plants in the United States by the turn of the century.

It was assumed that uranium would become scarce and expensive. Instead, there have been discoveries of new uranium reserves in the United States as the demand for uranium has slowed down. Our domestic uranium industry is currently experiencing a glut and facing the prospect of having to close mines and lay off workers.

According to a June 1981 Los Alamos study, the price of uranium would have to reach $165 before breeders become competitive with light water reactors. The spot market price for uranium today is $20. The fact is that Clinch River will not be commercially viable until well into the next century, if ever.

Although Clinch River has been subject to several delays, we have not really lost any time. Indeed, it is clear from the testimony you have heard earlier today that the prospects for the economic viability of breeders have not become much greater, but rather have faded further into the distant future.

DOE's own blue-ribbon Energy Research Advisory Board has recognized that there have been significant changes that have occurred in America's energy picture during the last decade. In November 1981, ERAB gave the Clinch River breeder reactor a low rating and concluded that "the construction of a breeder reactor demonstration at this time is not an urgent priority." Citing the current budgetary constraints, they recommended that this commercial demonstration project be "delayed until a future time."

The cost of Clinch River has soared over the years. Now the Congress own auditors, the U.S. Government Accounting Office, predict that the Clinch River construction and its 5-year demonstration will top $8 billion. Clinch River will not produce a profit during the remainder of its 30-year lifetime. Indeed, the project will lose an additional $2.6 billion and, thus, it may ultimately cost the taxpayers over $11 billion.

As the price tag for Clinch River soared, so has the cost to the taxpayers. Clinch River was originally conceived as a 50/50 partnership between the Federal Government and the private sector. Today the taxpayer is responsible for some 97 percent of the cost of this project and its demonstration.

It is significant that DOE is no longer able to provide a clear, economic justification for Clinch River breeder reactor for the commercial demonstration of breeder technology at this time. It is my hope that DOE will come forward to this committee with an economic cost-benefit analysis which will demonstrate that the taxpayers will benefit from this investment of billions of dollars of Federal funds.

It is important to note that the termination of the Clinch River breeder reactor does not mean an end to breeder research and development in the United States. DOE has a large breeder base R&D program and will continue without this uneconomical demonstration plant.

It is essential that we remember that we do not have to enter a race with other nations to build essentially what will be a nuclear Concorde. I also would like to submit for the record an article which appeared in Science Magazine in December 1982 on the European fast breeder programs. This is an excellent article which illustrates that the difficulties facing us with the Clinch River breeder reactor are by no means unique and that other countries are suffering the same problems with their breeder programs: High cost-overruns, delays, and economic problems.

Mrs. Bouquard. We will receive that in consideration of inclusion in the record.

[Material follows:]

Europe's Fast Breeders Move to a Slow Track

The U.S. Clinch River reactor is not the only project faced with mounting economic and political problems

Paris. Europe's enthusiasm for fast breeder nuclear reactors is rapidly running out of steam, faced with increased costs, decreased projections of electricity needs, and across-the-board delays in the construction of conventional light water reactors on which a commercially viable fast breeder program would depend.

In both Britain and West Germany there is now serious talk, if not of abandoning fast breeder development completely, at least of putting a freeze on expansion plans until future needs can be perceived more clearly. Nigel Lawson, Britain's minister of energy, told Parliament on 29 November that the British government remains committed to the long-term development of fast breeder reactors, but that commercial orders for fast reactors are not expected until after the year 2000.

In France, President François Mitterrand has not so far invoked his pre-election call for a temporary halt in the construction of France's technological jewel, the Super-Phénix fast breeder reactor at Creys-Malville in the Rhône valley. This has stimulated concern that pressure to retain the breeder may be coming from the French military, attracted by the high-grade plutonium that will become available from the reactor blanket (see box). However, the government announced earlier this year that it was reducing its future commitment from five to one more fast reactor after Super-Phénix, and there are doubts about whether it will decide to go even this far, at least without considerably more international support.

It is all very different from the heady enthusiasm that existed up to the end of the 1970's. Even 2 years ago, at the time of the International Nuclear Fuel Cycle Evaluation (INFCE) studies, the talk was of having 50 gigawatts of breeder reactor capacity worldwide by the year 2000. Today, many economists claim breeders will not be competitive with light water reactors for the next 50 years. Even the more optimistic, such as Georges Vendreyes, head of industrial applications of nuclear energy at France's Commissariat à l'Energie Atomique (CEA), admit that breeders are not likely to become commercially attractive until the beginning of the next century.

Confidence in the technical potential of fast breeders as an eventual important energy source remains high, particularly in countries that lack access to domestic energy resources and are reluctant to accept the implications of heavy dependence on foreign supplies of uranium.

Political enthusiasm, however, has cooled, for the OPEC-inspired oil price rises have provoked a steady decline in the rate of growth of electricity demand. This, combined with licensing restrictions imposed by public concern about safety, has caused delays in conventional nuclear programs to such an extent that the date at which they would be able to sustain a viable fast breeder program, based on reprocessed light water reactor spent fuel, is receding further and further into the distance.

> "... the need for the breeder ... is rapidly diminishing."

Furthermore, the resultant decreased demand for natural uranium is making it increasingly difficult to argue that fast breeders are urgently needed to compensate for an imminent evaporation of uranium supplies. "There now seems to be enough uranium at least until the first decade of the next century, so that the need for the breeder from the supply side is rapidly diminishing," says one analyst with the nuclear energy agency in Paris. "The long-term need for the breeder is still there; but compared to the thinking at the time of INFCE, the prospects have been put back by 20 to 30 years."

The changed economic and political climate has affected European countries in different ways, depending on the stage of their breeder programs. France, still out at the head of the pack with the world's first commercial fast breeder, the 1200-megawatt sodium-cooled Super-Phénix, is in an easier position than some. Completion of Super-Phénix is currently scheduled for 1984, and no decisions about the next step (currently thought of as Super-Phénix II) need be made until at least 1 or 2 years later.

When it comes, however, the decision will not be easy. Until recently, the future of fast breeders in France seemed well assured. The prototype Phénix, a 250-megawatt reactor, has been providing power for the French utility Electricité de France (EDF) since 1973, and most of the technical questions about fast breeder operations seem to have been solved. Furthermore, French politicians have proudly displayed fast breeders as one technology in which the country is well ahead of its international competitors.

Various factors, however, have dampened some of the enthusiasm. After 8 years of "working like clockwork," in the words of Vendreyes, Phénix sprang a leak in April of this year in its cooling system, leading to a fire when the sodium came in contact with the air. The accident put the reactor out of operation for several weeks and stimulated a debate about fast breeder safety.

Furthermore, the cost of Super-Phénix, jointly financed with German and Italian partners, has been rising alarmingly. Estimated 5 years ago to cost 4 billion francs ($550 million at current exchange rates), the latest estimate is that it will cost about 12 billion francs ($1.7 billion). Even allowing for the first-time costs of a new engineering enterprise, this means that a commercial fast breeder based on the Super-Phénix design would cost about twice as much as a conventional light water reactor of the same size.

A third factor, perhaps even less predictable, is politics. During his election campaign in 1980, Mitterrand's apparently skeptical stance toward fast breeders helped him secure support not merely from the environmental movement—to whom the whole idea of a plutonium economy remains a can of worms—but also from members of the powerful union the Confédération Française Democratique de Travailleurs, which has been waging various well-publicized campaigns around nuclear safety issues, such as the safety of working conditions for its members at the La Hague reprocessing plant.

Since his election, Mitterrand has backpedaled on his previous criticisms of the nuclear industry, well aware that for other sectors of the labor movement, it represents an important source of jobs. Work on Super-Phénix has continued virtually uninterrupted; last year, for example, Prime Minister Pierre Mauroy underlined the government commitment to fast breeders by announcing plans to expand La Hague with a facility to produce plutonium for Super-Phénix.

By announcing that no political decision will be made about the future of the French fast breeder program until operating experience has been gained with the Super-Phénix, Mitterrand has been able to keep the lid on what could become a damaging political conflict between different groups of his supporters. But, fueled on the one hand by unfavorable economic conditions and on the other by concerns that breeders could become a principal source of plutonium for France's *force de frappe*, the tensions are not far beneath the surface.

The situation is more delicate in Germany, which is still struggling to complete construction of its own prototype reactor, the 300-megawatt sodium-cooled test reactor SNR-300 at Kalkar, which started in 1973. This is being built by the consortium Schnell-Brüter-Kernkraftwerksgesellschaft (SBK), headed by Germany's largest utility Rheinisch-Westfalisches-Elektrivitätswerk (RWE). Belgium and the Netherlands are each contributing 15 percent of the cost and Britain's Central Electricity Generating Board 2 percent. Of the German share, electric utilities agreed to absorb 8 percent of the construction costs, the rest being covered by the federal government.

When originally planned, Kalkar was expected to be ready by 1978. It now looks as if completion will not be until at least 1986; and if the German government is unable or unwilling to raise the necessary finance, either from its own resources or from utility and nuclear construction companies, final completion could still be postponed indefinitely.

Various factors have contributed to the delay. For example, the reactor has had to go through a lengthy and detailed series of licensing procedures, which themselves have become increasingly more strict in response to growing public concerns about the safety of nuclear power. In addition, there have been various design changes, some the result of new licensing requirements, others of miscalculations in the original plans.

Each of these factors has helped increase the costs. At the beginning of the

Breeders and Bombs

Questions were raised in the West German Federal Parliament, the Bundestag, last week about whether German funds are being used to help produce plutonium for French nuclear weapons. The questions were prompted by an article in the weekly magazine *Der Spiegel*, which claimed that the Super-Phénix sodium-cooled fast breeder reactor is intended to produce plutonium for the French military, and that customers of the German utility that is providing 16 percent of the funding for Super-Phénix were therefore unwittingly helping to finance the planned buildup of France's nuclear forces.

The questions were quickly dismissed by both the German and the French governments, which pointed out that the whole Super-Phénix project is being overseen by Euratom, and that this should be sufficient to ensure safeguards against the diversion of civilian plutonium to military purposes. But the incident reflects the type of political difficulty that could arise over multilateral cooperation in fast breeder research and development—difficulties that the United States has already encountered in its own nuclear cooperation agreements, most recently in its efforts, through the Nuclear Nonproliferation Act, to keep a handle on the plutonium contained in the light water reactor fuel sold to other nations.

The attraction of the fast breeder, from the military point of view, is the high purity of the plutonium that can be extracted from the uranium oxide blanket after it has been bombarded with fast neutrons from the reactor core. One visitor to the United Kingdom's Atomic Energy Authority's fast breeder at Dounreay was told that the purity was as high as 98 percent. There are several cheaper and more convenient ways of producing weapons-grade plutonium; but if fast breeders are built, the temptation to the military to make use of the plutonium in the blanket will be strong.

France has never admitted that it intends to do this. Indeed, at present it has plenty of plutonium from its own military reactors. However, a veil of secrecy is generally drawn over where the country will get the plutonium it needs to fulfill future commitments to building new weapons. Nuclear critics claim they can discern from a few public statements made by those close to the military program a logic that points toward the fast breeder.

In 1973, for example, a report on the military applications of nuclear energy prepared by the Commissariat à l'Energie Atomique (CEA) recommended that the production of military nuclear material should take "advantage . . . of civilian programs . . . in order to limit the costs." In 1978 General Jean Thiry, previously director of France's military centers for nuclear testing, and subsequently an adviser to the head of the CEA, wrote that France was able to make large quantities of nuclear bombs "since fast breeders will provide ample supplies of the necessary plutonium." Most recently, an article in a weekly newsletter *L'Energie* stated boldly that the future supply of weapons-grade plutonium, currently produced by the aging reactor G-3 in Marcoule, was "assured" by Super-Phénix which would produce enough high quality plutonium to fuel 60 atomic bombs a year. "Super-Phénix is obviously becoming the technical base of the French *force de frappe*," the author, L. Lammers, an economist with Electricité de France, declared. To some critics, the message is clear. Given the declining economic interest in fast breeders as a source of electric power, they ask, what is the explanation for continued political enthusiasm? "The answer is succinct: the military needs breeders," wrote Yves Lenoire and Michel Genestout in the October issue of the popular French magazine *Science et Vie*, the source of *Der Spiegel*'s broadside against West German involvement in Super-Phénix. So far, the French authorities have kept a discrete silence on the issue, other than pointing out that although it is not a signatory of the nonproliferation treaty, France is voluntarily obeying International Atomic Energy Authority safeguards on its civilian nuclear installations.

Whether the complaints are, in themselves, sufficient to deter the French, who take a strong nationalistic pride in their ability to determine their own nuclear future, from moving in this direction is open to speculation.—**D.D.**

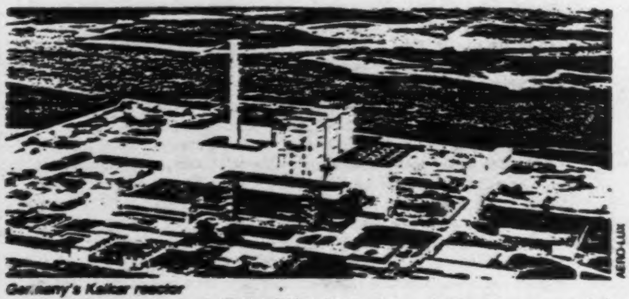
1970's, it was estimated that Kalkar would cost 1.355 billion marks ($550 million at current exchange rates), but this projection rose steadily during the decade. In February 1981 new estimates were made public that the completion of Kalkar would cost 5 billion marks. A lengthy series of negotiations followed, during which the utilities and the nuclear industry agreed to share the extra costs with the government—but only provided that the federal parliament give the full project its approval.

This goal was almost reached earlier this fall. After 3 years of discussions, a special parliamentary commission of inquiry agreed by a narrow majority to recommend to the parliament that the construction of Kalkar should be completed and the reactor be allowed to start operation. A parliamentary debate now scheduled for 3 December had been expected to endorse the commission's recommendations with little difficulty.

Since then, two separate events have raised new doubts. With the change of government in September, the Social Democrats have closed ranks with the critics. On 24 November, the party agreed to endorse the resolution being put before parliament stating that a number of important economic and safety questions still need to be answered before Kalkar is given final approval. To some observers in Bonn, the most significant aspect of this move is that it represents the breakup of the previous all-party coalition on which support for the fast breeder has depended.

Given the extent of both public and private investments, as well as the number of construction jobs at stake, parliamentary criticism in itself is unlikely to be sufficient to halt SNR-300. However, in September, it was announced that the costs had once again been recalculated and that they were now expected to be at least 6.5 billion marks ($2.6 billion). Germany's research and technology minister, Heinz Riesenhüber, was reported last week to have written to the federation of German industrialists saying that the Bonn government does not intend to increase its contributions either to Kalkar or to another controversial nuclear project, the high temperature reactor, which has also encountered major financial problems.

Industrial sponsors of the project remain, at least in public, optimistic that the money will be found somewhere. Critics of the fast breeder, however, suggest that the new cost increases may prove to be the final death blow.


AERO-LUX

Germany's Kalkar reactor

Cost overruns and political opposition

All this casts even more doubt on what was to have been the next stage in Germany's fast breeder program, the construction of a demonstration commercial reactor known as SNR-2. Roughly comparable in size to Super-Phénix, this is officially planned to be jointly financed with French and Italian participants, and the final design has been virtually completed. Even the most optimistic supporters of fast breeders in Germany, however, accept that construction is unlikely to start before the end of the 1980's—"This time, we plan to get the construction license granted before we start building," says one official—and many will not be surprised if, even if Kalkar is completed, SNR-2 is put on the shelf for many years.

In Italy, doubts about current plans for fast breeder development have not taken such a public form. Italy has recently made a substantial increase in its support for all forms of energy research—including fast breeders, which now consume 39 percent of the nation's energy R & D budget—as part of its response to the energy crises of the late 1970's. However, most of Italy's support for fast breeders is going into Super-Phénix. It has agreed with France to shoulder 33 percent of the construction costs (and as a result has received orders for about one-third of the components, and will receive the same proportion of the electricity when it is produced).

Domestically, the delays in Italy's conventional nuclear program—only one full size nuclear reactor has so far been built with one more under construction—means that discussion about the need for commercial fast breeders is not even expected to begin until the mid-1990's. The most Italy is aiming for at present is to keep up with the state of the art through its contribution to Super-Phénix and the construction of its own 120-megawatt experimental fast reactor PEC (Prova Elementi Combustibili), designed to develop Italy's domestic nuclear capabilities and to study various aspects of fast reactor functioning.

Even this, however, is running into economic problems. Earlier this year, faced with the calculations that, rather than the 650 billion lire ($450 million at current exchange rates) estimated in 1980, PEC was now likely to cost 1400 billion lire ($950 million), the Italian government asked its Commission on Economic Planning to carry out an investigation of the project to determine whether it should still be supported. The commission appointed an advisory panel from the Comitato Nazionale per l'Energia Nucleare e Energie Alternativa (CNENEA), which gave the project a green light on technical grounds, and at the beginning of last week the commission itself approved the project. Officials from the CNENEA estimate that, once allowance is made for inflation, the real cost increase is only about 15 percent. Given a more stable political and economic environment, construction would probably proceed without interruption; but with the current political crisis in Italy, together with growing demands from the international banking community for broad cuts in public spending, the future of the project is still highly uncertain.

Similar uncertainty, though based on different reasons, exists in Britain. Up to now, the United Kingdom has been at the forefront of fast breeder research, with its 250-megawatt reactor in commercial operation at Dounreay in the north of Scotland since 1975, and a current research and development program costing about 110 million pounds ($136 million) a year. Britain is also working on a design for a 1300-megawatt commercial demonstration fast reactor.

In practical terms, the British government is now faced with the question of what to do next. Some observers feel that, faced with the recent weakening of economic arguments in favor of fast breeders, the answer is likely to be "wait and see." The British Conservative government faces the political challenge of bringing to fruition a program to construct ten light water reactors announced by Prime Minister Margaret Thatcher, the first of which, at Sizewell in Suffolk, is due to become the subject of a public inquiry in January. In the circumstances, an earlier government promise of an inquiry into the commercial development of fast breeders now seems a distant prospect.

Certainly, the fast breeder does not lack enthusiastic supporters in Britain (or elsewhere in Europe, for that matter), such as Walter Marshall, until recently head of the United Kingdom Atomic Energy Authority. The main British utility, the Central Electricity Generating Board (which Marshall now heads), however, basing its assessment on economic rather than technical arguments, has always been less enthusiastic. For example, it turned down an invitation to contribute toward the cost of the UKAEA-financed fast breeder at Dounreay, which according to estimates by Colin Sweet of the South Bank Polytechnic in London, has a spotty operating record, reaching only 6.8 percent capacity over its first 8 years of operation.

Britain's medium-term plans for the fast breeder are currently being thrashed out in the U.K. Department of Energy. As noted earlier, substantial investment is likely to be delayed for the next 20 years.

Given the cost escalation, almost all countries agree that there is a strong case—again in principle—for the next step toward a commercial demonstration fast reactor to be taken internationally. The French, for example, have long said that they would welcome more foreign partners in the development of Super-Phénix II, a topic which is said to have been the subject of recent negotiations both with the Americans (a possible substitute for the Clinch River liquid metal fast breeder?) and with Japan.

Again, however, the hurdles to international collaboration are high, ranging from security and legal concern about the control of plutonium, to the equitable distribution of construction contracts. Furthermore, any effort to mount an international project is seen by some critics as an attempt by nuclear supporters to evade domestic criticism. "It looks as if the breeder people are going for another Concorde syndrome, so that if they get an international treaty, it will be impossible to cancel it," says Walter Patterson of Britain's Friends of the Earth.

At the time of the INFCE studies, any decision not to proceed with a commercial program of fast breeder reactors was portrayed as a major political gamble. Today the technology has lost its imperative. As a result, proceeding with the rapid development of fast breeders, given demand uncertainties and the apparent medium-term adequacy of uranium supplies, is coming to be seen in Europe as an economic and political gamble whose outcome is unpredictable—and perhaps equally risky.—DAVID DICKSON

Mr. SCHERR. It is not surprising that congressional enthusiasm for Clinch River has waned over the years. The project is alive today only because of a single vote margin in the Senate last December. During the closing days of the 97th Congress, the House-Senate conferees agreed not to permit actual construction of the the Clinch River breeder reactor plant to proceed and instructed DOE to look at alternative funding arrangements which would reduce Federal budget requirements and stimulate greater participation from the private sector.

This report on alternative funding is due March 15, and we all look forward to it. However, I think anyone who has followed developments in the nuclear area during the past 5 years must be dubious about the willingness or the capability of nuclear utilities and vendors to assume a significant portion of the risk associated with this commercial demonstration project. It is unlikely that any genuine new cost-sharing agreement can be reached, and we see no indication yet that either the vendors or utilities have any intention of making significant financial contributions to this project beyond the original $257 million they agreed to. Indeed, there are several utilities which are already holding back on their previous commitments to provide financial support for the project.

We think that the best measurement of the cost effectiveness of the Clinch River project is the willingness of the private sector to actually contribute a substantial portion of the money needed to carry out this commercial demonstration. It appears that the nuclear industry does not believe that the Clinch River is a good project. While they are willing to take corporate welfare from the Federal Government, they appear unwilling to risk their own capital. The Clinch River breeder reactor is not a good investment. Business executives know that it makes no sense to throw good money after bad.

It appears that the Department of Energy has already failed in its attempt to bolster private sector support for the Clinch River breeder reactor. According to a recent New York Times article, the DOE is falling back to a range of Federal guarantee proposals in order to attempt to keep the project alive. The taxpayers coalition opposes such guarantees because they will not relieve the American taxpayer of ultimate responsibility for the project's funding.

The bottom line is that the U.S. nuclear industry is already in deep financial trouble and is in no position to help the taxpayer out of the financial quagmire represented by Clinch River. Across this Nation there are now 36 nuclear powerplant sites at which construction has either been abandoned or deferred. It is at these sites where the future of nuclear power in this country will be determined, not at Clinch River.

With the United States facing the largest budget deficits in our history, the Congress must make some difficult choices. It is clear that this is not the time to spend billions of dollars on the commercial demonstration of a nuclear reactor that no one wants or will need for at least the next 40 years. Inertia alone cannot be the justification for continued Federal funding for the Clinch River breeder reactor.

Once again, we urge the committee to terminate the Clinch River breeder reactor now.

Thank you.

Mrs. **Bouquard**. Thank you very much.

[The prepared statement of S. Jacob Scherr follows:]

STATEMENT OF
S. JACOB SCHERR
and
JILL LANCELOT-GREENBAUM
ON BEHALF OF THE
TAXPAYERS COALITION AGAINST CLINCH RIVER

I am S. Jacob Scherr, a Senior Staff Attorney with the Natural Resources Defense Council. I am accompanied by Jill Lancelot-Greenbaum, Director of Congressional Affairs for the National Taxpayers Union. We are pleased to have this opportunity to present the views of the Taxpayers Coalition Against Clinch River regarding continued Federal funding of the Clinch River Breeder Reactor (CRBR).

The Coalition is made up of 16 member organizations representing millions of American citizens. It is a uniquely diverse coalition of taxpayer, fiscal conservative, labor, consumer, environmental, scientific, and church groups.1/ The member organizations differ in their attitudes towards nuclear power. They vary in their views as to the proper role of the Federal Government in the development and demonstration of new energy resources. However, they joined together last Spring to provide the facts to the American public and their elected representatives regarding the enormous and unnecessary waste of taxpayer's money on the Clinch River Breeder Reactor Project.

Over the course of the last year, a number of other respected institutions and opinion leaders have reached the same

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1/ Coalition Member Organizations include: National Taxpayers Union, Natural Resources Defense Council, International Association of Machinists and Aerospace Workers, Environmental Policy Center, United Methodist Church: General Board of Church and Society, United Steelworkers of America, Rural America, National Audubon Society, Sierra Club, United Church of Christ: Office for Church and Society, Council for a Competitive Economy, Union of Concerned Scientists, Congress Watch, Friends of the Earth, Church of the Brethren: Washington Office, New Jewish Agenda.

conclusion that further Federal investment in the CRBR is economically unjustified. These include the Heritage Foundation, the Federation of American Scientists, the Wall Street Journal, the League of Women Voters, Readers Digest, National Review, and analysts from the American Enterprise Institute, Hoover Institution, and the Rand Corporation. Reflecting this broad consensus, the House of Representatives decided in December 1982, by a vote of 217-196, to terminate CRBR funding in FY 1983.

In our view, the task now before this Committee should not be attempting to keep this floundering pork barrel alive, particularly at a time when the federal budget deficit is approaching $200 billion. Rather the Committee should move to deauthorize the CRBR and to reorient our breeder research and development based upon the economic realitites of the 1980's.

The CRBR project was authorized over a decade ago to demonstrate the commercial viability of breeder reactors in a utility environment. The CRBR is not a research and development project. As David Stockman pointed out in 1977,

> The breeder reactor is not the mythical cornucopia of boundless, free energy supplies. It is a commercial process designed to reduce the cost of nuclear generated electricity by substituting capital investment in plant for purchase of a raw material--uranium.

The decision over ten years ago to proceed with the CRBR was based upon economic analyses which showed that breeders would become economically competitive in the near term with conventional light-water reactors as the price of uranium soared. These analyses, which were dubious at the time, are now severely out-of-date.

It was assumed that the 7 percent annual electric power growth rate which prevailed in the United States during the 1960's would continue. Instead it has dropped well below 3 percent.

It was assumed that the frantic pace at which utilities were ordering nuclear power plants would continue. It was projected that there would be 1000 nuclear power plants in the U.S. by the year 2000. Instead there have been no new plants ordered in the last five years; and since 1975 almost 80 orders have been cancelled. Now DOE is projecting that there will be only some 160 nuclear power plants in the U.S. by the turn of the century.

It was assumed that uranium would become scarce and expensive. Instead, there have been discoveries of new uranium reserves as the demand for uranium has slowed down. Our domestic uranium industry is currently experiencing a glut and facing the prospect of closing mines and laying off workers. According to a June 1981 study by Los Alamos National Laboratories, the price of uranium must reach $165/lb. before the breeder becomes competitive with the light water reactor. The spot market price of uranium is now $20/lb.2/ The fact is that Clinch River will not be commercially viable until well into the next century, if ever.

2/ NUEXCO, "Monthly Report on the Nuclear Fuel Market," January 1983.

DOE's own blue-ribbon Energy Research Advisory Board (ERAB) has recognized the changes that have occurred in the U.S. energy picture. In November 1981, ERAB gave the CRBR a low rating and concluded that "the construction of a breeder reactor demonstration at this time is not an urgent priority." Citing the current budgetary constraints, they recommended that this commercial demonstration project be "delayed until a future time."

The cost of the CRBR has soared over the years. When this project was originally conceived in 1971, it was expected to cost $400 million. Now, the Congress's own auditors, the U.S. Government Accounting Office (GAO), predict that CRBR construction and its five-year demonstration will top $8 billion[3/]--a twenty-fold increase! The GAO states further that the CRBR will not produce a profit during the remainder of its 30-year lifetime. The project will lose an additional $2.6 billion dollars; and, thus, it may ultimately cost over $11 billion. As the price tag soars, so does the cost to taxpayers. Although the CRBR was originally conceived as a 50-50 partnership between the Federal Government and the private sector, the taxpayer is now responsible for some 97 percent of its costs.

DOE is no longer able to provide an economic justification

[3/] U.S. Government Accounting Office, "Analysis of the Department of Energy's Clinch River Breeder Reactor Cost Estimate", December 10, 1982.

for the CRBR. Instead breeder proponents increasingly rely upon the argument that if we do not plunge ahead, the United States will lose out in breeder technology to other nations. The fact is that the difficulties facing the Clinch River Breeder Reactor are by no means unique to the United States. Every breeder program in the world has suffered from precisely the same problems: staggering cost-overruns, interminable delays, intractable technical troubles, and economic realities. The international competition to build a commercial breeder is going nowhere. Even the acknowledged leader, France, has deferred plans to build follow-on plants to their commercial prototype plant, the Super Phenix. This is not surprising since the costs of its construction will now run more than twice as much as for a comparable light-water reactor.

A termination of the CRBR does not mean an end to breeder reactor research and development in the U.S. It is important to recognize that DOE's breeder base R&D program is substantial and will continue without this uneconomical demonstration plant. We don't have to enter the race to build a nuclear Concorde!

These arguments which we have recited against the CRBR are not new. In response, Congressional enthusiasm for the CRBR has waned over the years. The project is alive today only because of a single vote margin in the Senate last December. During the closing days of the 97th Congress, the House-Senate Conference Committee agreed not to permit CRBR construction to proceed and instructed the DOE to "vigorously explore proposals, including a reconsideration of the original cost-sharing arrangement, that would reduce Federal budget requirements for the Clinch River project or project alternative, and secure greater participation from the private sector."[4]

The DOE "alternative funding" report is due March 15, 1983. Anyone who has followed the nuclear industry over the past five years should be dubious about the willingness and/or ability of these nuclear utilities and vendors to assume a significant portion of the risks associated with CRBR. To date, the private sector continues to carry only 3% of the cost. It is unlikely that any new genuine "cost sharing" agreement can be reached. We have seen no indication yet that the nuclear industry has any intention of making significant financial contributions beyond the $257 million they agreed to a decade ago.[5] Indeed, several utilities are already withholding their financial support for the project.[6]

The best measurement of the cost-effectiveness of the CRBR is the willingness of the private sector to actually contribute a substantial portion of the money needed to carry out this commercial breeder demonstration. It appears that the nuclear industry does not believe the CRBR is a good project. While they are willing to take corporate welfare from the Federal Government, they appear to be unwilling to risk their own capital. The CRBR is not a good investment. Business executives know that it makes no sense to throw good money after bad.

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[4] U.S. House of Representatives, "Making Further Continuing Appropriations and Providing for Productive Employment for the Fiscal Year Ending September 30, 1983: Conference Report," to accompany H. J. Res. 631, Report No. 97-980, December 20, 1982, p. 186.

[5] Letter of Agreement between the Project Management Corporation and the Atomic Energy Commission, 1973.

[6] Wisconsin Electric Power Company; Kansas Power and Light Company; City of Bandon, Oregon; Central Lincoln People's Utility District (Oregon); Omaha Public Power District (Nebraska); Department of Water and Power, City of Los Angeles; Brazos Electric Power Cooperative, Waco, Texas.

It appears that DOE has already failed in its attempt to bolster private sector support for the CRBR. According to a recent New York Times article, the DOE is falling back to a range of Federal guarantee proposals to keep the CRBR alive.[7/] The Taxpayers Coalition Against Clinch River opposes such guarantees because they will not relieve the American taxpayer of ultimate responsibility for the project's funding.

Clinch River proponents contend the project will produce $8 billion in net revenues over its lifetime. If indeed the project will "pay for itself", then the private sector should be willing to risk its own capital now and recoup the revenues at a later date. Over the years, the nuclear industry has verbally supported CRBR every step of the way. They have been willing to invest hard money in expensive public relations campaigns and lobbying efforts for the CRBR, yet remain unwilling to increase their contributions to an amount representing genuine cost sharing.

[7/] New York Times, "Reagan Hopes to Keep Breeder Reactor Plant Alive," February 16, 1983, p. A15.

The bottom line is that the U.S. nuclear industry is already in deep financial trouble and in no position to help the taxpayer out of the CRBR quagmire. Across this nation, there are 36 commercial nuclear power plant sites where further construction has been abandoned or deferred. These are where the future of nuclear power in the United States will be determined, not at Clinch River.

With the United States facing the largest budget deficit in our history, the Congress must make some difficult choices. It is clear that this is not the time to spend billions of dollars on the commercial demonstration of a nuclear reactor that no one wants or will need for at least the next forty years. Inertia alone cannot be justification for continued Federal funding for the CRBR. DOE's own Energy Research Advisory Board has identified other energy technologies which represent a much sounder investment of scarce taxpayer's dollars.

Once again, we urge the Committee to terminate the Clinch River Breeder Reactor Project now.

Thank you.

Mrs. BOUQUARD. Mr. Scherr, in reference to licensing by the NRC, I believe the Energy Reorganization Act of 1974 requires licensing of LMFBR demonstration plants, not because it is a commercial plant. R&D projects are not required to make a profit.

You state that CRBR is not an R&D project. By doing so, you contradict the testimony given in the past 2 years before this committee by many highly qualified scientists and engineers, as well as the GAO.

Mr. Scherr, what qualifies you to make this statement?

Mr. SCHERR. Madam Chairman, I have gone back and I have looked at the initial authorization hearings for the Clinch River breeder reactor project before the Joint Committee on Atomic Energy. I have reviewed the materials prepared by the AEC and ERDA in the midseventies regarding Clinch River. I have reviewed the most recent programmatic impact statement prepared by the Department of Energy on the LMFBR program. All of these make it quite clear that the Clinch River breeder reactor is not part of the base R&D program but, rather is the first step in the commercial demonstration of the reactor.

I think it is significant that other breeder reactors now operating in the United States, such as the EBR-II and the FFTF facilities, are not licensed, and that, indeed, Congress said that the Clinch

River breeder reactor must be licensed in 1974 in order to carry out the mission of this project, which supposedly was to show that such breeder reactors could be viable in the utility environment. The point we are making is that the Clinch River is essentially a commercial breeder reactor project and——

Mrs. **Bouquard**. Do you have a technical background, Mr. Scherr?

Mr. **Scherr**. No, I don't, but I am an attorney and I have examined all these materials and documents. If Clinch River was a research and development project, solely a research and development project, then why is it necessary to have it licensed by the Nuclear Regulatory Commission, as would any other commercial nuclear power plant?

Mrs. **Bouquard**. Dr. Weinberg, do you agree that the Clinch River project should not be regarded as an R&D project?

Dr. **Weinberg**. We are getting into a semantic question. You can call it commercial or you can call it R&D, depending upon whether you are looking at the hole or at the donut.

There is no question at all in the minds of any of the technical people who are associated with the Clinch River breeder that there will be some very, very important, substantial, central, technical issues that will be clarified by Clinch River.

To give one example, the Clinch River breeder will be the first that will have what is called a heterogeneous parfait core, which has advantages as far as the breeding performance and advantages as far as the burnup is concerned.

I think people who are not involved in heavy engineering development—and I use the word "heavy" engineering development—who have not had the experience, are perhaps unaware of the enormous amount of new information that one gains by actually building something, seeing how it works, seeing what the real problems are rather than the presumptive problems that you try to figure out in advance. We always find that there are many more such problems than we anticipated initially.

I say again, as I said in my written testimony, that we seem to be applying a double or a triple standard; that the questions which are being asked of the Clinch River breeder are not the same questions that are being asked of the competitive inexhaustible energy sources. The big power towers for solar, for example, certainly are not economical. That does not mean I do not favor going ahead with them. Of course, we should go ahead with them to see how good they can be. The fusion devices—nobody says we are going to have fusion for a very, very long time.

I say, for goodness sakes, let's be clear about what it is that we are trying to achieve and let's separate our strategy from our tactics.

Mrs. **Bouquard**. Dr. Weinberg, in your testimony you suggested that, even if we proceed ahead with Clinch River on schedule, that they are not going to be commercially deployed until about 2020, what our previous panel said as well.

Based on our present estimates of uranium reserves and the present rate of consumption in once-through reactors, would not this reserve essentially be depleted in this time frame?

Dr. **Weinberg**. I do not really want to make a judgment on that, Madam Chairman, because we seem to be finding more uranium but we cannot be sure of it. When I am confronted with this question, the answer that I always give——

Mrs. **Bouquard**. Maybe I should have said "probable reserves."

Dr. **Weinberg**. Well, the reserves that are now on the books.

I guess the answer that I really like to give to this question is that we do not really know what the uranium situation is going to be. For example, if there is a huge increase in the use of nuclear energy outside of the United States, then there would be big pressure on U.S. reserves that is not really factored in. The way I put it is that the risk that we incur in going ahead with, say, Clinch River or going ahead with the breeder more generally and not needing it is a lesser risk than the risk we incur in not going ahead with the breeder and then finding, because the uranium price is going up, that we need it.

That is about all I am prepared to say on the question of uranium reserves.

Incidentally, the question of when do you need the breeder, being related to how much reserve you have, this, of course, was the central issue when we first talked about this 45 years ago. We realize that is still an open question.

Mrs. **Bouquard**. Mr. Scherr, I was interested in your cost estimates. I believe you took it up to $10 billion. You said that the GAO cost estimate was around $8 billion. My staff has discussed this in some detail with GAO staff that is responsible for this cost study, and they just will not lay claim to this figure because they say that it includes interest imputed on the national debt, and it presumes the total cost will come from borrowed funds, and this is certainly a gross miscalculation.

Can you identify any other Federal-funded R&D project in which imputed interest is charged to a project?

Mr. **Scherr**. Madam Chairman, I think we are into a question of semantics. It is on view that this is not——

Mrs. **Bouquard**. I said, is there any other R&D project that this imputed interest is a part of the overall project cost?

Mr. **Scherr**. Our view is that this is a commercial demonstration facility. If this were being built by a utility, the utility would have to pay interest. My understanding is that other Federal public works projects do have to take into account the cost of interest. I think that is appropriate in this situation as well.

Mrs. **Bouquard**. Do you know another R&D project in which this has been done?

Mr. **Scherr**. No, Madam Chairman.

Mrs. **Bouquard**. You argue that terminating CRBR would not impact breeder reactor R&D. If we do not focus our R&D on actual operating plants, then why on Earth would you want to sustain an R&D base? What would the purpose of it be?

Mr. **Scherr**. This is an issue that I am not prepared to discuss at this point. What we have to do now is to decide that we are not going to build Clinch River and to take a hard look at our whole breeder R&D effort and reorient it in a way that makes sense, given the economic realities and the timeframe in which it is going to be necessary to develop breeder reactors. I am not saying that everything should be abandoned other than the base R&D program, but that there is a need to reorient the whole effort in the absence of Clinch River.

Mrs. **Bouquard**. Would you give your timetable for the breeders?

Mr. **Scherr**. I heard this morning witnesses speaking about 2020 as a date in which breeders would become economically competitive. Other experts have suggested it may be even further into the next century. I do not agree with Dr. Weinberg that there is a one-sided risk of delay in not having a breeder when it is needed. I think we are going to know when the prospects for the breeder are becoming economical enter the 20- or 30-year timeframe. We are not going to see nuclear powerplant orders being cancelled, but rather new orders. I think it is going to take about 10 years of sustained growth in the nuclear power industry before breeders become even on the horizon economically competitive.

Mrs. **Bouquard**. Would you give your timetable for the development of a breeder program?

Mr. **Scherr**. I am not in a position to do that. I would be happy to give that some thought and to submit that for the record.

Mrs. **Bouquard**. If you are telling us that we ought to abolish the program right now, then you ought to be able to have something in its place.

Mr. **Scherr**. Madam Chairman, I have not suggested that we abolish the program. I am saying that I think the program needs to be reoriented toward a longer timeframe and a more realistic assessment of the resources that are available, not only for this program but for other competing R&D programs.

Mrs. **Bouquard**. Mr. Scherr, I would suggest to you, if you are going to advocate that we abolish this national program, that you ought to come up with something better in its place.

Mr. **Scherr**. Madam Chairman, I have not suggested that we abolish the LMFBR development program. I have come here on behalf of the Taxpayers Coalition only to argue that we should deauthorize the Clinch River commercial breeder demonstration project, which is part of that program.

Mrs. **Bouquard**. Would you give us your positions on the impact of low-cost breeder designs?

Mr. **Scherr**. I would agree that that is perhaps an area which one might want to look at in terms of coming up with a new design for the breeder that would hold more economic promise than does Clinch River. That might be part of a reoriented breeder R&D program.

Mrs. **Bouquard**. I would suggest to you, before we consider abolishing a program of longstanding interest and the biggest commitment that the industry has ever made for an R&D project, that you certainly have an obligation and commitment to come up with something better.

Mr. **Scherr**. Madam Chairman, once again, I just have to emphasize for the record that I have not, nor has the Taxpayers Coalition, recommended the abolition of the LMFBR program in this country. The only thing that we are opposed to is the commercial demonstration of a reactor technology that is not needed at this time.

Mrs. **Bouquard**. Dr. Weinberg, from a proliferation and nuclear safeguard perspective, does not the breeder offer the opportunity to consume fissile plutonium, essentially making this material inaccessible to improper use; whereas, storage of spent fuel from LWR's can promulgate a possible threat of misuse for generations to come?

Dr. **Weinberg.** All of this, of course, depends upon how you conceive the structuring of a breeder system. The breeder, after all, is both a reactor and a chemical processing plant. If the chemical processing plants are confined to the weapon states, then the issue of proliferation is a nonissue.

My very strong recommendation would be that, should one go into breeders on a large scale, that they really be confined to either the weapon states or the states one has confidence in are not going to proliferate. That, it seems to me, almost goes without saying.

Of course, at the moment that is rather an academic question because that, of course, is very far down the line.

Mrs. **Bouquard.** Thank you very much.

Dr. **Weinberg.** However, I guess I would like to comment again on some of the things that were revealed in the questioning of Mr. Scherr, my colleague on the panel.

I guess we in the nuclear community, rightly or wrongly, suspect the motive, if not the actions, of people who dislike the Clinch River breeder. We somehow have this sense that the strategy is get the Clinch River as a prelude to getting the whole LMFBR program, as a prelude to getting the whole nuclear program.

I think those who hold that view, and I know many of my good friends on the other side of the aisle, if I might say, really do hold that view, really ought to level with the American people that this really is what their agenda is.

This notion that you kill the one active project in favor of sort of diffused technology development, which then becomes very vulnerable, I just do not believe it. One reason I do not believe it comes again from the experience that I have had.

You probably know, Madam Chairman, that I really am not the world's greatest enthusiast for the LMFBR. I think there are other breeders that I like better. In fact, many years were spent at the Oak Ridge National Laboratory developing what I still think is a very elegant idea, the molten salt reactor. Everybody agreed that that was a very nice idea for breeder reactors.

What happened then was that the molten salt reactor experiment was killed, and that was a prelude—well, we were told, "We won't have the experiment," which was an actual integrated reactor, "but we will continue with the base program." Therefore, the base program was continued. However, then people said, "Well, why do you have a base program if you have no intention of really doing anything with it?" The result was that the United States gave up on the molten salt reactor.

Therefore, I would really plead with my good colleagues on the other side of this debate to really level with us. Is it really nuclear energy that you dislike? Then you should say so. Is it really liquid metal fast breeders that you dislike? You should say so. Is it Clinch River that you dislike? You should say so. If it is Clinch River that you dislike, then you have to state why a double standard is being used with respect to Clinch River and the other inexhaustibles and, second, why, if you have a choice out of that $602 million that is being spent for all of LMFBR research—why should you take Clinch River out of the budget rather than the base technology.

Ms. **Lancelot-Greenbaum**. May I respond to some of these issues?

Mrs. **Bouquard**. It is Mr. Walker's time. I think he would be happy if you would respond.

Mr. **Walker**. Yes, fine.

Ms. **Lancelot-Greenbaum**. Thank you, Madam Chairman and Congressman Walker. I appreciate that.

I would like to make a couple comments. I want to raise this from the antinuclear versus nuclear arena to the economic arena. The Taxpayers Coalition considers that is what it is all about.

Certainly we can say that in previous years perhaps it was antinuclear, but you now have the Heritage Foundation; the League of Women Voters; the Federation of American Scientists, who has Hans Bethe, who is very pro nuclear, as you all know, and certainly pro Clinch River, coming out against Clinch River at this time. The reason is because we cannot afford it right now.

We are faced with budget deficits, astronomical budget deficits, somewhere around the neighborhood of $200 billion. I think we need to address this point.

The concerns that Congressman Walker stated earlier are certainly the concerns of the National Taxpayers Union as well as the Taxpayers Coalition.

Basically, I think what we would like to see is that we have, instead of verbal support from the industry and the utilities, saying how much they want Clinch River—and we hear this all the time, time and time again: "We need to have Clinch River. We want Clinch River. We support Clinch River." What we are asking for is the hard dollars. We want to see the industry take the risk with their capital, not take the risk from the taxpayers. The taxpayers are now taking most of the burden; 97 percent of the economic burden is on the taxpayer.

We are asking that before construction starts let's not go ahead with construction on the good faith commitment from the industry but with hard dollars.

We keep hearing again that Clinch River is a symbol for the nuclear industry. I just want to make a comment that perhaps instead of the savior of the nuclear industry, it may be its ultimate demise.

That is basically all I really want to say, but just again to reiterate the point that we want the industry to take the risk and bear the burden and put up front the dollars that need to be invested.

Mr. **Walker**. Yes. I thank you for your statement. I am pleased that you took the time to do that.

I might say also from the standpoint of what the agenda is, if I raise serious questions about Clinch River breeder reactor, it is not because the antinukes in my district think I am one of them. As a matter of fact, I would suspect that they would be horrified to think that I would be numbered among them.

However, the fact is I think there can be serious questions raised without raising questions of whether or not we are trying to bring down the whole nuclear industry, which is not the intent.

I have seen some examples in the recent past that the nuclear industry is doing a pretty good job of bringing itself down, but I think the Clinch River breeder reactor may be one symbol of that kind of myopic attitude about some of the issues that are swirling around it.

I would point out to you, as to the Heritage Foundation, I would think you would have a hard time saying that the Wall Street Journal's agenda includes wiping nuclear energy off the face of the earth or that National Review or Reader's Digest or the American Enterprise Institute, or a lot of them who have raised questions about the cost of the project really are among those who are trying to do away with nuclear energy.

Let me also say, though, that I think we, as people who are concerned about some of these things, have to be careful about some of the cost estimates as well. I know GAO came out with this $8 billion thing, and that you can extend out to $11 billion. I think it is important that as we consider things in this committee that we do as apples and apples. We do not add interest costs in.

I would say to you that one of the problems we have with this is that I think there is a problem of dealing with the issue here. Ultimately this project was supposed to be costed in a way that it was going to be sold. It was going to be sold for some negotiated price. It would be interesting to know whether or not that negotiated price is going to include the interest payments that would normally accrue to a project.

However, even if you take the $3.6 billion that we have to deal with in terms of this committee, if you eliminate the $11 billion, if you eliminate the $8 billion, and do not deal with those as emotional issues, but take only the $3.6 billion, you are still talking about one whale of a chunk of money that is coming out of the overall energy budget of what this committee handles, of what this country is doing at the present time. That is one of the key concerns I have.

Let me get to some specific questions here.

Dr. Weinberg, you state that the capital cost of the breeder seems to be very high now but that continued development work ought to result in cheaper breeders.

Dr. **Weinberg**. I hope so. I cannot guarantee that.

Mr. **Walker**. I guess one of the questions I have is, what kind of reductions do you see coming about as a result of that development work? Are we talking about lowering the cost to something that is in the realm of the three quarters of a billion dollars that it would take to build a light water reactor of similar capacity?

Dr. **Weinberg**. That is a very, very difficult question to answer. I just cannot answer it.

I think there are ideas that some people have about rationalizing the design of the intermediate heat exchangers, for example; the possibility of getting fuel cycles and fuel elements that are somewhat cheaper; the possibility of making pumps that are less expensive.

I guess one just cannot really answer that, and I am perfectly prepared to concede that it may be that breeders just are too doggoned expensive and will always remain too doggoned expensive, in which case that's it; we will just have to choose some other path for energy. It would be very disappointing if that happens, but I cannot say that it might not happen.

Mr. **Walker**. Do you believe that there is a $3 billion research and development premium in this project? In other words, that is about the difference between the cost of a light water reactor of similar capacity?

Dr. **Weinberg**. Oh, yes. I have no doubt whatsoever. Mr. Walker, I have no doubt whatsoever about that.

Let me again explain or state again what the context of the breeder is. We have only three inexhaustible energy sources that we know of. We do not know whether or when we will need any of them. Therefore, trying to develop an inexhaustible energy source must really be placed not primarily in an economic framework, but very much more in the same framework as you put going to the Moon. It is a national goal that has been established. Perhaps we should reconsider whether that should be a national goal and prepare to discuss that.

Mr. **Walker**. I think that is one of the questions——

Dr. **Weinberg**. I think that is a central question.

Mr. **Walker**. I think that is one of the questions that is being raised here. It is an exhaustible supply of energy, provided that somebody is willing to put up the capital cost of building the plants, but only if that kind of money is willing to be spent on the plants does it become an inexhaustible energy supply. If it is uneconomical to put that kind of capital investment into the energy supply, you have then done an awful lot of research on something that, while it may be inexhaustible in theory, in practicality is never going to come on line.

Dr. **Weinberg**. I agree completely with you, Mr. Walker, absolutely. I only say that the same consideration then must be applied to the other inexhaustibles—fusion and solar.

Mr. **Walker**. I don't——

Dr. **Weinberg**. I agree completely with you.

Mr. **Walker**. I don't argue with that.

Dr. **Weinberg**. We have no disagreement.

I would say the $3 billion, if that is what it takes to develop a new inexhaustible energy source which has a good chance, let's say, within the next 75 or 100 years of being economical, I would say that is pretty cheap.

Mr. **Walker**. One of the problems I have with the way we handle issues in this committee from time to time—and I am not talking specifically about this subcommittee; I am talking generically about the whole committee—is the fact that the people who seem to have wed themselves to various energies totally reject the other energy options that are out there, and you have almost a political war among the energy sources.

Mrs. **Bouquard**. Would the gentleman yield at that point?

Would you name one member of this committee that is wed to one source of energy? Would you name one member?

Mr. **Walker**. Well, I am not into naming——

Mrs. **Bouquard**. You made a charge, Mr. Walker.

Mr. **Walker**. No; I am just saying generically that in the committee what I have found is that the people who are wedded to solar concepts tend to want to reject everything that is nuclear oriented; people who are wedded to nuclear tend to reject everything that is in the alternative.

My point is simply that I think we ought to be holding every one of the energy sources that is before this committee to the same standards.

Dr. WEINBERG. I agree completely.

Mr. WALKER. I do not think we ought to be giving special dispensation to Clinch River any more than I think we ought to be giving special dispensation to solar. I think ultimately what the job of this committee, with the limited funds we have available, to make certain that we bring to the market enough energy options that the consumer can select, and they are either going to be proven viable or unviable by the marketplace.

Then we have to decide some priorities as we go along as to what stands the best chance of surviving in that kind of competition. One of the questions that has to be raised each time we come against these issues is capital costs, costs to the individual for installation of equipment. I think all of those things have to be looked at in terms of our priorities. That is the kind of question that I am trying to raise in terms of the Clinch River issue.

I think it is important, for instance, that Mr. Scherr pointed out that the Energy Research Advisory Board in 1981 said that the construction of the breeder reactor demonstration at this time is not an urgent priority. I would appreciate it, if you have a copy of that report, that it that be submitted for our record here, for this year's record. I think that is the key question here: With a billion dollars to spend, do we spend $350 million for one project?

Dr. WEINBERG. I guess I would only add, Mr. Walker, that we are planning to spend, I guess, $602 million on the breeder program. I think the question ought to be put to the Department of Energy: If you had the choice of spending that money on the base program or on Clinch River, which would you spend it on? I do not think that question has ever been put to the Department of Energy precisely in those terms. I think it is time that it should be. Perhaps it is long past time.

Mr. WALKER. I raised the question of priorities the other day when the Department of Energy was here. Of course, they remained committed to this project, but I must admit that it was a rather hesitant commitment. There was the question of whether or not to commit a considerably large chunk of money compared to everything that they are trying to do.

Mr. Scherr, to come back to the question, and I think the chairwoman raised a good question, on where we go from here, I am not so certain that any of us want to abandon the breeder. I think that there is an obligation on the part of the people who come before the subcommittee here to say—and I think you did—that you do not want to abandon the breeder.

Let me raise a specific. When I was in Japan recently, the Japanese indicated that they were interested in pursuing joint cooperation on some of these things. In all honesty, they were concerned about the fact that we may be backing off Clinch River.

However, they also indicated that they are willing to cooperate on some of these programs.

Wouldn't it be logical to assume that we might have some international cooperation, so that around the world we have a joint participation in development of breeder technology?

Mr. **Scherr**. Before I respond to your question, let me make one quick point.

Mrs. **Bouquard**. Mr. Walker, the first panel testified that that is going on at the present time.

Mr. **Scherr**. I think that there is a difference between breeder technology and solar and fusion. It is quite clear that breeders are a much different stage of development. The question now really is, do we spend billions of dollars to build a commercial breeder demonstration plant?

I think that the Department of Energy should explore every means possible to economize on the breeder program, including taking advantage of the work that has been done overseas. I see a problem with our possibly duplicating work that is being done elsewhere.

It is significant to note that while the United States was investing a lot of money on light water reactors, the French were spending their scarce R&D dollars on developing breeders. Now they have a breeder which is a commercial prototype, which costs 2½ times as much as the light water reactor. They have, in a sense, won the race, but what they have built is another Concorde.

In sum, I would agree that international cooperation is one way to go.

Mr. **Walker**. As I say, I do not think the United States wants to find itself in a position at some point in the future that, if we develop a need for breeder technology, we are totally unfamiliar with all of the development work that went into it.

I think it is also apparent that if we can be a part of a process that keeps us in the forefront of that development process, we ought to try to be there. It may well be, though, that that can be done through some kind of international cooperation. I am pleased to hear that the panel mentioned that as one of the things that is ongoing.

If we have to look at energy options, if we move beyond the Clinch River project and we have to look for options, it seems to me an expanded effort might not produce everything that Clinch River would have produced, but then it might not cost as much, either.

Mr. **Scherr**. I agree with that. Another fundamental question is, who is going to pay for this commercial development? At what point does the responsibility of the Federal Government stop and the responsibility of the private sector start? I have noticed that DOE has proposed to spend $15 million for the design of a large breeder development plant to follow on from Clinch River. They promised that the private sector would pick up the tab in building that plant, but, in light of what I have heard earlier this morning, are utilities really going to be willing to invest money in the late 1980's or early 1990's in a large development plant if there is no prospect for commercialization for still 30 or more years? It is now time, in my view, for the industry to say, yes, we see a future for the breeder in the short term and we are willing to invest our capital in it, or it is time for the U.S. Government to reorient our program, taking note of the longer timeframe involved and the opportunity for international cooperation.

Mr. **Walker**. The chairman has reminded me that my time is up. Thank you.

Mrs. **Bouquard**. Thank you very much.

Thank you very much for being with us today.

We will be happy to submit questions to you for your response for the record. They will be made part of the record of our hearings. You will agree to respond to questions in writing?

Mr. **Scherr**. Yes, Madam Chairman. We will be happy to do so.

Mrs. **Bouquard**. Thank you.

[Material to be supplied follows:]

Federal Energy R&D Priorities

REPORT OF THE ENERGY RESEARCH ADVISORY BOARD

Department of Energy
Washington, D.C. 20585

December 4, 1981

Honorable W. Kenneth Davis
Deputy Secretary of Energy
1000 Independence Avenue, SW
Washington, DC 20585

Dear Ken:

I am pleased to forward the Report of the Energy Research Advisory Board on Federal Energy RD&D Priorities. This report was prepared in response to your request on August 13, 1981, to review the relative merits of each major R&D program.

The Board is in full agreement that the Federal Government must continue to support research and development for the technologies upon which the nation's energy future depends. Although all the members (except for Philip Handler) participated in the development of this report and reached a consensus on most recommendations, there are a few statements that represent majority opinions where every member did not agree to every statement. Dissenting views on those recommendations for which overall agreement was not possible are included in the Appendices.

Sincerely,

Louis H. Roddis, Jr.
Chairman
Energy Research Advisory Board

Enclosure

cc:
Thomas J. Kuehn, ERAB
Joel Snow, ER-4

Department of Energy
Washington, D.C. 20585

December 4, 1981

Louis H. Roddis, Chairman
Energy Research Advisory Board
110 Broad Street
Charleston, SC 29401

SUBJECT: Letter of Transmittal of the R&D
Panel RD&D Priorities Report

Dear Lou:

This letter transmits to you the RD&D Priorities Report. The report contains inputs from all members of the Board, and except where minority views are presented, there is general agreement with its contents.

As you know, the methodology required members of the Panel to evaluate each R&D program in terms of a specific set of criteria. The evaluations were combined to arrive at composite figures of merit which were then reviewed and discussed by the R&D Panel. At the outset of this project, there was some uneasiness about the validity of the evaluation methodology. To guard against possible difficulties, each section of the report, after drafting by two members of the Panel, was reviewed and discussed thoroughly by the full Panel before final judgments were made.

I believe that the evaluation methodology worked quite well. It provided assurance that the key criteria were explicitly considered, and this helped us identify quickly the sources of agreement and disagreement. The second stage of the process provided for resolution of the areas of disagreement. Where necessary, members of the Board voted to arrive at final recommendations. You offered the opportunity to members to advance minority views, and such views are included in the final report.

The preparation of this report in such a short time was a formidable task. In my view, the Board did remarkably well to complete this study on time.

Sincerely,

John S. Foster, Jr.
R&D Panel Chairman

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FEDERAL ENERGY RD&D PRIORITIES

I. EXECUTIVE SUMMARY

Background

In a letter dated August 13, 1981, the Deputy Secretary of Energy asked for the advice of the Energy Research Advisory Board (ERAB) on DOE's R&D priorities and on "hard choices" the Department must soon make as to "which programs to pursue vigorously and which to de-emphasize based on a realistic appraisal of both our energy options and energy needs for the foreseeable future." This report of ERAB responds to that request in the context of continuing pressure for further reductions in DOE's budget. This report presents recommendations on priorities within DOE's non-defense R&D program and suggests where funding should be changed, either increased or decreased relative to the President's FY 82 budget request.

During the last year, major changes in policy have been made; these have already led to changes in DOE's objectives, strategies, R&D funding and internal allocations of R&D funds. In carrying out its study of DOE's R&D priorities, the ERAB has generally accepted these new policies and has confined its recommendations to matters of science, technology and engineering. In some areas, however, particularly in electric supply and conservation, the ERAB's application of these policies has resulted in somewhat different conclusions than those reflected in the President's FY82 budget. Moreover, the application of these policies has led to recommendations by the ERAB that differ significantly from those it made to the Secretary of Energy on September 5, 1980 in the interim report on research and development needs in which the Board applied funding policies of the previous administration.

Recommendations of this study resulted from application of both a new assessment methodology developed by the R&D Panel of ERAB and more conventional and traditional evaluation techniques. The new methodology required Board members to evaluate each R&D program in terms of a specific set of well defined criteria. This insured that each program was evaluated comprehensively by each member. The evaluations of all R&D Panel members were then combined numerically. These composite evaluations were then used as the basis for more traditional judgments, discussions and consensus building, leading to conclusions and recommendations by the Board. The salient findings of the Board are:

- Funding relative to the President's FY82 budget request for the science and technology base programs should be increased in some programs and remain the same in others. Within these programs high priority should be given to:

  - research on the phenomena governing accumulation of CO_2 in the atmosphere from combustion of fossil fuels, climatic effects of this accumulation, tolerable levels of CO_2 and ways to control CO_2 accumulations

  - research into acid rain, its causes, effects and control technologies

- In the electric supply sector, priority should be given to supporting:

  - nuclear waste isolation research and demonstration
  - conventional reactor systems and safety
  - the LMFBR base program
  - uranium enrichment R&D

- Programs in which reductions can be made include:

  - small reductions in magnetic fusion

  - significant reductions in the Clinch River breeder,* the light water breeder, electricity transmission, and high temperature geothermal

  - phase-out of funding for hydropower and magnetohydrodynamics

- The Board noted that the electric supply technology is receiving a fraction of DOE's funding that is substantially in excess of its contribution to present and future energy supplies.

- In fuels supply technologies, the Board believes that technologies such as enhanced oil and gas recovery, while urgent because of near term benefits, will be adequately supported by the private sector. DOE's support of these programs can thus be reduced. The Board also recommends that:

  - the major Federal effort in synthetic fuels research and development be directed at innovative concepts at the laboratory and small pilot-plant scale. In view of the financial guarantees available from DOE and the Synfuels Corporation, DOE's budget for cost-shared projects at the large pilot plant and demonstration-plant scale and for in situ shale recovery should be reduced.

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*See dissenting opinion and additional remarks in Appendix D.

  - the funding level for R&D directed at producing liquids and gases from biomass and the production of alcohol is at an appropriate level.

  - ERAB urges that the parts of Advanced Research and Environmental Control Technology R&D (FE) concerned with technologies to control SO_x, NO_x and particulates emissions be increased and strengthened at the expense of other activities in this program.

- On an overall basis within the Department of Energy, R&D funding for energy conservation and end-use technology is underfunded, particularly when compared with funding levels for supply technologies. A balance that better reflects the opportunities, importance, and nature of the Federal role in supporting private sector response needs to be achieved. This should be achieved by increases in funds allocated to buildings and community systems and industrial conservation.

- The Board believes that if its recommendations are implemented, a net reduction in DOE's budget will result.

II. INTRODUCTION

A. Background and Purpose

On April 30, 1980, the Deputy Secretary of Energy* requested that the Energy Research Advisory Board (ERAB) participate in the Department's review of the technology base component of its R&D programs by addressing the following concerns:

- The adequacy of the research underpinning for technology development programs
- Possible gaps or duplications of effort
- The balance among research performers in the universities, laboratories, and industry
- Significant R&D opportunities that our programs may be missing.

As a result of more than 16 public meetings during July and August 1980, a report was prepared by an R&D Panel and seven subpanels covering each of the major DOE program areas. This report titled, R&D Needs in the Department of Energy, was submitted to the Secretary of Energy on September 5, 1980, and recommended enhanced funding for a number of DOE program areas.

In the original request for an R&D study by ERAB, the Deputy Secretary expressed the view that this project should be a continuing effort through which ERAB would assist the Department in its R&D program evaluations. After the publication of the interim report, several members of the original panel continued to review various methodologies for evaluating R&D programs. On August 13, 1981, the Deputy Secretary* requested ERAB's recommendations on overall Federal energy R&D priorities specifically including the following concerns:

- The relative merits of each major R&D program with respect to such criteria as the technical and economic potential, urgency and lead time required, benefits and costs of Federal funding, contribution to energy security, health and environmental risks, and the appropriate Federal role;
- The appropriate R&D funding balance between electric power supply, fuels supply conservation, and technology base program areas;

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*See Appendix A.

- The appropriate program orientation and balance between research, development, and demonstration activities;

- The strategic R&D objectives for the near, mid, and long term.

In September 1981, the R&D Panel was restructured to include all members of ERAB who contributed individually to the evaluation of 49 program areas covering all energy R&D programs. The Panel met on September 24, 1981, to discuss the results of their evaluations (see Appendix B for details on methods and criteria) and to reach a consensus on its recommendations for R&D priorities. The R&D Executive Committee met on October 30, 1981, to revise the draft report before it was discussed and the body of the report approved by ERAB at its November 4-5, 1981 meeting.

In these times of budgetary restraints, it is imperative that maximum effectiveness be attained in the use of Federal R&D funds. It is essential that a rational basis for evaluating priorities and the proper balance of funding be used to allocate increasingly scarce fiscal resources. The purpose of this assessment is to provide the Secretary of Energy with ERAB's best advice toward the accomplishment of that goal. The ERAB devised a methodology for structuring the discussion of RD&D priorities and relative funding levels for energy RD&D. A brief description appears in section II.C.

B. Energy Policy Context of R&D: "The Federal Role".

Between our 1980 study and the present one a new Administration has re-defined the appropriate role of Federally-sponsored energy R&D. Differences in our conclusions and recommendations from the earlier study result to a considerable extent from this redefinition and our adherence to it -- with certain exceptions noted below.

The previous Administration defined an expansive role for Federally-sponsored R&D, including demonstration and commercialization. The new Administration, by contrast, proposes to:

- Drastically shift the emphasis from Federal sponsorship to reliance on the private sector. With few exceptions this includes total reliance on the private sector for demonstration and commercialization.

- Limit appropriate Federally-sponsored R&D to: 1) Basic energy science and technology base; 2) Energy R&D of a long-term high-risk character; and 3) Research on the health, safety, and environmental aspects of energy supply and use.

- Strive to reduce Federal expenditure and the Federal deficit.

ERAB's deliberations have reflected an expectation that Federal funds for R&D will be stringently limited for the foreseeable future. In evaluating R&D programs ERAB has conformed generally but not slavishly to this policy. We applaud greater reliance on the private sector whenever possible. We applaud the restoration of a free market in petroleum. ERAB believes that much, perhaps most, of new energy supplies and greater efficiency in energy use will in fact be achieved by higher energy prices. But ERAB is concerned that some energy R&D of great potential significance for the achievement of the Nation's energy goals will fall between Federal and industry responsibilities.

The new policy recognizes that private industry cannot be expected to do basic energy research or projects of a long term, higher risk character. But there are other circumstances in which it would be unrealistic to expect timely and effective assumption by industry of R&D responsibilities abdicated by the Government, however worthy the projects involved, and despite the provision of new generous tax incentives. Some of these circumstances are discussed below.

Some of the markets on which energy is sold are not "free." Oil and coal are the exceptions. A little over half our primary energy finds its way to consumers through the electric and gas utilities and the utilities are regulated, price-controlled industries, selling their products not at free market prices, but at controlled prices well below replacement cost. The consequences are that consumers of gas and electricity have less of an incentive to conserve (and therefore to undertake research on conservation) and that producers of electricity are so strapped financially that they cannot afford conventional additions to capacity, let alone demonstration projects or any expensive R&D. Gas producers are faring somewhat better and can look forward to eventual decontrol at the well head, but gas transmission and distribution will remain under control indefinitely and so presumably will the investor-owned electric utilities.

Both these regulated industries have weak incentives to spend on R&D. If successful, the benefits go to rate payers; if unsuccessful, the expenditure may be disallowed as "imprudent." In the case of electricity (but not gas) a substantial amount of R&D has been undertaken by large research-oriented equipment suppliers. And during the past decade the "invention" of a device for financing industry-wide R&D by rate payer levies through EPRI and GRI has enhanced the ability of both industries to respond to R&D needs and provided an alternative to some government-sponsored R&D, but the total annual budgets of the two institutions (less than $300M and $100M respectively) are far too small to permit them even to contemplate financing demonstration or first-of-a-kind commercial plants at a billion or more each.

Some energy related industries are too fragmented to organize and finance a strong R&D response to market signals. Individual units lack the financial strength, and realize too well that the benefits would accrue mainly to other units. Before the advent of agribusiness, the tremendous gains in agricultural productivity resulted from government and government-supported university research and an extension network to convey the results of the research to individual farmers. The building industry, to take an important example, is now similarly fragmented and similarly incapable of organizing and funding its own research.

Even where some larger units exist, industries with a strong R&D orientation and capability are the exception in America. Most of our industry-sponsored R&D is now highly concentrated in a few industries. The reasons may be historical, institutional, or adventitious. A strong R&D response to price signals requires both motivation and capability. In many cases the capability is simply lacking, and while it can be developed given time, the time required to build a strong research organization is measured in years.

A common reason for no response or inappropriate response by consumers to market signals is ignorance. EPA ratings of the fuel efficiency of automobiles, however faulty, focused attention on the potential savings and gave buyers useful guidance. The effect on the average fuel economy of new cars has been dramatic. In the case of buildings, particularly their heating and cooling, ignorance still reigns supreme. Almost no one knows what is cost effective at different prices, or where to go to get reliable, objective information. Almost no one knows how much reduced ventilation in super insulated buildings is safe or how to reconcile tightness and safety. The retrofit problems are extremely complex, and even the best "house doctors" are only beginning to learn their job. In the meantime we are consuming more energy in heating and cooling residential and commercial buildings than in running our automobiles, and the potential savings are also greater. The government can provide some of the research needed to achieve them.

To conclude: ERAB in its evaluations of programs has taken the new policies and guidelines relative to the Federal role very seriously, but ERAB has made exceptions where there is reasonable certainty that timely and adequate response by industry and commerce is an unrealistic assumption, and that continued Federal research support is therefore still required, at least for a time.*

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*We have not, in this report, responded to the Deputy Secretary's request for advice on the respective roles of industry, university, and national laboratory R&D efforts. This will be a major focus of our new study on DOE laboratories, initiated on November 3, 1981.

C. Methods and Criteria

This assessment features an evaluation technique in which each member of ERAB evaluated 49 program areas covering all DOE energy R&D programs in terms of seven criteria for energy supply and conservation programs and five criteria for science and technology base programs. Each member evaluated the relative importance of these criteria and judged whether more, less, or the same amounts of money relative to the President's request for FY 1982 should be allocated to the various programs. The judgments of the Panel members were combined numerically to arrive at figures of merit for each program on the relative priorities of energy technologies and whether financial allocations to each program should be increased, held the same, or decreased relative to the President's request for FY 1982. The resulting figure of merit was used to rank the programs in order of importance.

Criteria used in evaluating the priority of each technology were selected and the definitions for each criterion agreed upon. The criteria for the R&D programs were technology potential, urgency, economic potential, benefit/cost, energy/national security, health/safety/environment, and federal RD&D role. The criteria for the Science and Technology Base programs were scientific potential, risk/benefit, mission impact, urgency and federal role. A more detailed definition of these criteria is given in Appendix C.

Each member of ERAB determined the relative importance of each criterion and then judged its importance for each technology. From this information normalized weighting factors for the criteria were determined. Using these factors and the criteria/technology judgement information, figures of merit were calculated for each technology. Recommended funding levels for each technology were also provided by ERAB members. This information was used as the basis for discussing recommendations of future funding -- namely, whether the funding for each program should be decreased, remain the same or be increased relative to the President's FY82 budget request.

The results of this method allowed for a systematic, well structured debate on issues where the level of agreement was not clear or where clear disagreement was obvious. It was also quite effective in identifying areas of strong agreement by ERAB on a particular value judgment. It is important to note that the assessment or evaluation methodology, which used decision questionnaires from each member was not intended to and did not "fix" the results of the final priority ratings. Rather the methodology was designed as an initial point of departure for discussion from which final conclusions would ultimately evolve -- conclusions that were not necessarily consistent with the initial ratings. Where reasonable consensus could not be reached, the expression of minority views is included.

III. ENERGY PROSPECTS

A. Supply and Demand Projections

Table III-A shows the latest DOE projections* of U.S. energy consumption for 1990 and 2000 compared with actual consumption for 1980. Table III-B shows similar projections for U.S. energy production and net imports.

The most striking aspect of recent supply/demand projections has been the sharp drop, especially over the last two years, in the projections for total consumption of energy in the years 1990 and 2000. Figure III-1 illustrates the point. What lies behind this development are (1) a much stronger user response to rising energy prices than had been expected; i.e., greatly and steadily increasing efficiency in the use of energy, which has been expressed as a less than proportionate increase in energy consumption associated with a given increase in GDP, gross domestic product, (see Figure III-2), and (2) a substantial reduction in the expected rate of economic growth. This double-barreled assault on earlier projections has now reduced them to the equivalent of an annual growth between now and the year 2000 of about 1 Q/yr (equal to 0.5 MBD of oil, or 40-50 million tons of coal per year, or a trillion cubic feet of natural gas per year).

A second characteristic of energy consumption and production projections is that there remains a sizeable band of uncertainty. This is especially disconcerting where imported oil -- the country's Achilles heel -- is concerned. Imported oil is the principal balancing factor, and thus carries the combined impact of uncertainties in all other source projections. For this reason there is wide divergence in estimates of U.S. oil imports ten or twenty years from now. Table III-B shows a range from 4 to 15 Q/yr (2 to 7.5 MBD) in 1990 and from zero to 11 Q/yr (5.5 MBD) in 2000. There are estimates outside this range.

With few exceptions, current projections expect the completion of most nuclear plants now on the books, though opinions differ as to time of completion during the next two decades. Even if new orders are placed, this will barely, if at all, affect the number on stream for the balance of the century.

Expectations for coal- or shale-based gases and liquids are modest, with many observers judging the projection of the Synfuels Act of 4.2 Q/yr (2 MBD) in 1992 to be substantially unrealistic. Projections of solar energy (narrowly defined to exclude hydropower, biomass, etc.) are

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*National Energy Policy Plan, USDOE, July 1981, DOE/PE-0029.

TABLE III-A

U.S. ENERGY CONSUMPTION
(Quadrillion Btu Per Year)

	ACTUAL	PROJECTED				% CHANGE
	1980	1990		2000		1980-2000
		MIDRANGE	RANGE	MIDRANGE	RANGE	
Direct Oil[1]	31.2	27	26-29	24	23-25	-23.0
Direct Gas[2]	16.7	18	17.5-18.5	20	18-22	19.5
Direct Coal	3.5	5.5	5.0-6.4	7.5	6.6-8.2	114
Direct Renewable[3]	1.8	2.7	2.6-2.8	4.2	3.9-4.5	133
Electricity	7.1	9.6	8.5-11	12	10-14	69
End-Use Consumption	60.3	63	59-67	68	62-74	
Conversion Losses*	17.7	24	21-27	32	28-36	
Total Consumption[4]	78.0	87	80-94	100	90-110	

1/ Includes coal liquids.

2/ Includes synthetic gas from naptha and coal.

3/ Not included in conventional accounting.

4/ Range results from varying GNP assumptions.

*Includes conversion losses in generation and distribution of electricity and in production of synthetic fuels from coal and oil shale, but not similar conversion losses associated with other forms of energy, e.g. losses in petroleum refining and gas transmission.

Source: National Energy Policy Plan, USDOE, July 1981.

TABLE III-8

U.S. ENERGY PRODUCTION AND IMPORTS[1]

(Quadrillion Btu Per Year)

	ACTUAL 1980	PROJECTED 1990 MIDRANGE	RANGE	2000 MIDRANGE	RANGE
DOMESTIC PRODUCTION					
Oil and NGL	20.5	18	16-21	20.0	17-24
Conventional	20.5	16.4	14.7-19.1	13.7	11.1-18.1
Unconventional[2]	--	1.7	1.0-3.0	6.1	4.2-8.5
Natural Gas	19.8	18.5	16-21	18.0	14-21
Conventional	19.8	17.4	14.6-19.7	14.7	11.4-18.2
Unconventional[3]	--	1.3	1.0-1.6	3.3	2.0-5.1
Coal[4]	18.9	27	24-30	42	37-45
Nuclear	2.7	7.6	6.7-8.7	10.6	7.4-14.0
Hydro/Geothermal	3.2	3.6	3.3-3.9	4.3	3.7-4.9
Renewables[5]	1.8	2.8	2.4-3.3	5.4	3.9-7.0
Total Production[6]	66.9	78	68-88	100	83-116
NET IMPORTS					
Oil	13.3	10	4-15	3	0-11
Gas	1.0	2	1-3	2	1-3
Coal	(2.4)	(3.5)	(2.3-4.3)	(5.9)	(3.4-8.4)
Total Consumption[7]	78	87	80-94	100	90-110

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[1] Ranges in production reflect uncertainties about US energy supply.

[2] Includes shale oil and incremental enhanced oil recovery, but excludes coal liquids.

[3] Includes unconventional gas production from tight sands, Devonian shale and geopressurized methane. Does not include synthetic gas.

[4] Includes coal production for synthetics and coal exports.

[5] Includes about 1.3 quads of biomass not currently included in EIA/DOE statistics.

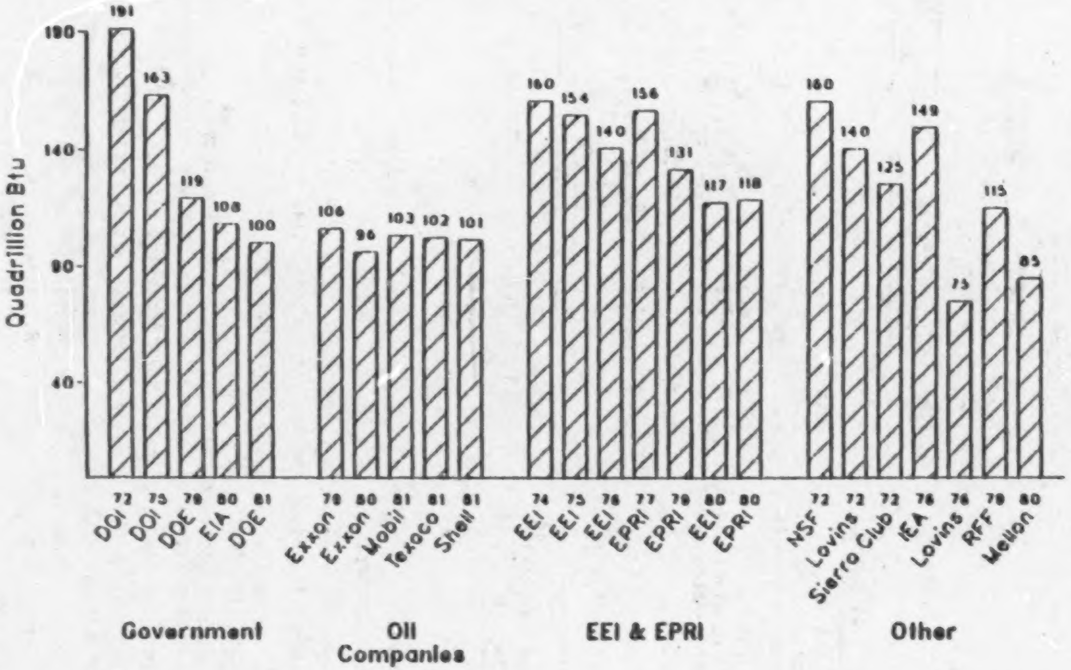
[6] Totals may not add due to rounding.

[7] Includes 0.8 quads of net stock increases in 1980. Range in total energy consumption results from varying GNP assumptions.

Source: National Energy Policy Plan, USDOE, July 1981.

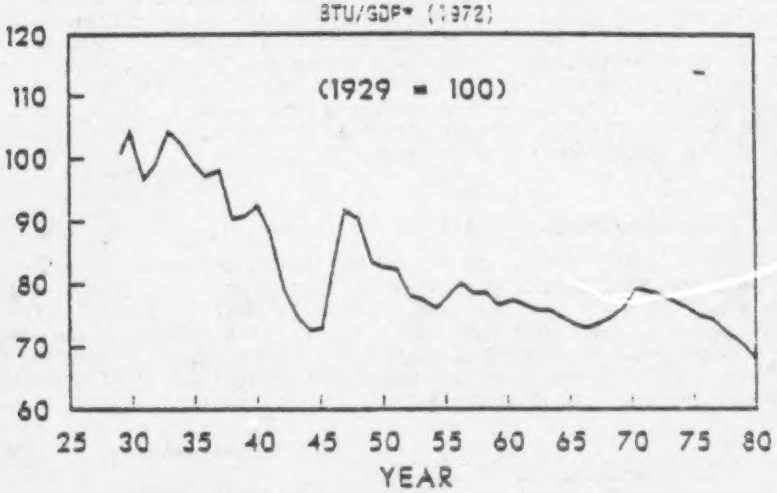
FIGURE III-1

TRENDS IN U.S. ENERGY DEMAND PROJECTIONS FOR THE YEAR 2000



Source: Office of Policy, Planning and Analysis, Department of Energy, 1981

Figure III-2



*GDP represents gross domestic product

Source: Work in Process. Resources for the Future.
Washington, DC: July 1981.

modest, largely connected with the continued depression in the consumer market, the cost of retrofitting and little progress in alleviation of institutional obstacles. Thus, for the next two decades oil, natural gas, and coal with a modest contribution of nuclear and an even more modest one of hydropower will remain the basic components of the U.S. energy supply.

Lest this quick sketch be interpreted as reflecting a mind-set of complacency, we should stress that a large number of assumptions may prove mistaken. These range all the way from the expected continuation of increased efficiency in use (i.e., how soon will that downward slope in the Btu/GNP ratio flatten out?) to the completion, more or less on schedule, of all nuclear plants now being constructed or having construction permits. Finally, a major perturbation in the oil import segment would play havoc with all projections.

B. Energy R&D Budget Analysis

Table III-C (FY1981) and III-D (President's proposals FY 1982) analyze the DOE budget by output energy form (electricity, fuels, and conservation) related to the resource base. Tables III-E and III-F analyze the budget by the same output energy forms related to the timing of impact: near term (next 10 years), mid term (1990-2010) and long term (beyond 2010). These tables are based on a categorization of programs selected by ERAB (see Appendix B-3).

C. Energy R & D Balance and Timing

Initial inspection of the FY 81 and FY 82 Federal energy R&D budgets (Tables III-C and III-D) reveals what appear to be imbalances in the program.

- There is very heavy stress on electrical technology in FY 81, further accented in FY 82, although it is noted that fluid fuels constitute our principal vulnerability.

- Similarly, within electricity, federally-sponsored nuclear programs are receiving a larger proportion of funding than the expected nuclear share of the U.S. energy mix during the next few decades.

- Finally, conservation, a very small fraction of the energy R&D budget in FY 81, is further and drastically reduced in FY 82, although it has so far contributed much more than supply augmentations in reducing our dependence on insecure oil imports.

TABLE III-C

FY 81 Budget as a Function of Technology Area and Energy Form, Millions of $

Output Energy Form Resource Base	Electricity	Fuels	Utilization and Conservation	Science and Technology Base	TOTALS
Conservation	-	-	311.5	-	311.5 (7%)[9%]
Nuclear & Fusion	1793.1 *	-	-	-	1793.1 (39%)[50%]
Coal	66.6	492.4	37.4	-	596.5 (13%,[16%]
Solar	224.3	49.6	363.1	-	637.0 (14%)[18%]
Geothermal	153.6	-	-	-	153.6 (3%)[4%]
Oil/Gas/Shale	-	78.9	-	-	78.9 (2%)[2%]
Science and Technology Base	-	-	-	979.3	979.3 (22%)
TOTALS (% of Total) [% less science and tech base]	2237.6 (49%) [63%]	621.0 (14%) [17%]	712.0 (16%) [20%]	979.3 (21%)	4549.9 [3570.6]

*Centrifuge R&D costs included, construction costs excluded.

[] signify Science & Technology Base funding excluded.

TABLE III-D

President's FY 82 Budget as a Function of Technology Area and Energy Form, Millions of $

Output Energy Form Resource Base	Electricity	Fuels	Utilization and Conservation	Science and Technology Base	TOTALS
Conservation	-	-	126.7	-	126.7 (3%)[5%]
Nuclear & Fusion	2022.2 *	-	-	-	2022.2 (53%)[72%]
Coal	-	282.4	38.8	-	321.2 (8%)[11%]
Solar	66.9	30.5	128.7	-	226.1 (6%)[8%]
Geothermal	46.8	-	-	-	46.8 (1%)[2%]
Oil/Gas/Shale	-	46.5	-	-	46.5 (1%)[2%]
Science and Technology Base	-	-	-	1073.4	1073.4 (28%)
TOTALS (% of Total) [% less science & tech base]	2135.9 (55%) [76%]	359.4 (9%) [13%]	294.2 (8%) [11%]	1073.4 (28%)	3862.3 [2789.5]

*Centrifuge R&D costs included, construction costs excluded.

[] signify Science & Technology Base funding excluded.

The questions whether these apparent imbalances are truly misallocations, or are justified, are addressed in detail in later sections of the report, and ERAB's recommendations for specific allocations within the overall budget are summarized in the conclusions at the end of the report.

No "correct" balance among energy forms and resources can be defined _a priori_: it would be absurd, for example, to assign coal or natural gas a "fair" share of Federal research dollars if there are no promising research projects in those areas which industry cannot be expected to undertake.

Tables III-E and III-F illustrate the Reagan administration shift toward research with longer range impacts. ERAB does not question this shift as a general proposition as long as it recognizes valid exceptions. Indeed, private industry is not likely to undertake long-range high risk R&D. It is also the area in which energy R&D can expect the highest payoffs and addresses the great national energy objectives -- affordable and environmentally benign sources of electricity and fluid fuels, used efficiently, for the indefinite future.

A summary of the timing impact of the various supply technologies used in preparing Tables III-E and III-F appears in Appendix B.

TABLE III-E*

FY81 Budget as a Function of Energy Form and Timing of Impact, Millions of $

	Near	Mid	Long	TOTALS
Electricity	827.2 **	539.6	870.8	2237.6 (49%)[53%]
Fuels	96.3	482.5	42.0	620.8 (14%) [17%]
Utilization and Conservation	509.2	203.0	- -	712.2 (16%)[20%]
Science and Technology Base	-	-	979.3	979.3 (21%)
TOTALS (% of Total) [% less science & tech base]	1432.7 (31%) [40%]	1225.1 (27%) [34%]	[912.8][26%] 1892.1 (42%)	4549.9 [3570.6]

*The timeframe for impact of the various technologies used in making the above table is given in Appendix B.

**Centrifuge R&D costs included, construction costs excluded.

[] signify Science & Technology Base funding excluded.

TABLE III-F*

President's FY82 Budget as a Function of Energy Form and Timing of Impact, Millions of $

	Near	Mid	Long	TOTALS
Electricity	802.1 **	406.1	928.0	2136.2 (55%)[77%]
Fuels	60.7	274.0	24.4	359.1 (9%)[13%]
Utilization and Conservation	174.2	120.0	-	294.2 (8%)[10%]
Science and Technology Base	-	-	1073.4	1073.4 (28%)
TOTALS (% of Total) [% less science & tech base]	1037.0 (27%) [37%]	800.1 (21%) [29%]	[952.4][34%] 2025.3 (52%)	3862.9 [2789.5]

*The timeframe for impact of the various technologies used in making the above table is given in Appendix B.

**Centrifuge R&D costs included, construction costs excluded.

[] signify Science & Technology Base funding excluded.

IV. ELECTRIC-RELATED SUPPLY PROGRAMS

A. Introduction

Electric-related supply programs constitute \$2.1B of the FY 82 President's budget in energy supply R&D. Of this, \$2.0B is devoted to nuclear fission and fusion R&D. The programs classified under this heading are on average larger in size than those in other R&D categories. This is because programs involving nuclear fission and nuclear fusion necessarily involve large research teams and also frequently involve expensive equipment and facilities for demonstration projects. This applies whether the impact of the program is near term as in research on conventional reactor systems, or long term as in fusion research.

The extent to which these programs should be financed by the Federal Government rather than by private industry is regarded by ERAB members as a key criterion. In many programs the Federal Government has assumed responsibilities (uranium enrichment, nuclear waste disposal and nuclear safety) that are not now assumed by private industry. In other programs (e.g., magnetohydrodynamics, breeder reactors, magnetic fusion) the risk is presently too great and the time scale too long for substantial private industry funding. For such programs the key criteria for continued government funding are the chance of technical success and the ultimate potential for providing a secure energy supply.

A major shift in the Administration's Energy Policy has been to give increased support to assuring the viability of the light water reactor (LWR) electric power industry. In order to carry out this new policy, ERAB recommends that the Administration give high priority to:

- R&D in nuclear waste disposal, particularly in accelerating early demonstration of specific, most promising waste disposal methods
- R&D on current generation LWR's

The summary of ERAB conclusions on priorities and funding for electric related supply is given in Table IV-A.

B. Near Term Nuclear Programs

Conventional reactor systems (\$81.5/\$68.0)* Increased funding for R&D on conventional reactor systems is recommended. Increased funding should be concentrated in high pay-off areas -- Three-Mile Island analysis, high burn-up fuel, safety related research and lower enriched fuel for research reactors while high temperature gas reactor funding has a lower priority.

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*FY81 funding/FY82 President's Request in million \$ are shown in parenthesis.

Nuclear waste programs ($499.6/$617.6) ERAB thinks that the proposed funding for these programs is satisfactory, even though they have the highest priority. Funding increases are not considered necessary because technology is regarded as available; the main obstacles are political. It is recommended that demonstration and site work should be accelerated. Safe waste disposal is critical for assuring the viability of the light water reactor cycle.

Uranium enrichment programs ($142.3/$149.7) There is strong agreement that funding for advanced isotope separation and advanced centrifuge R&D should be continued. It should be noted that $293.3M in FY81 funds and $695.8M in FY82 funds for construction of the near term gas centifuge capacity were excluded from consideration of R&D expenditures as the decision on this project should be based on normal payback criteria. In this regard, the ERAB recommends that consideration be given to formation of a quasi-government or private corporation to handle enrichment on a commercial basis.

Uranium resources assessment ($25.9/$5.8) The President's 1982 budget for this program represents a substantial reduction from past plans. ERAB recommends that funding be continued at approximately the 1982 budget level so that gathering of readily accessible data and periodic publication of reports can be continued.

C. Long Term Nuclear Programs

Liquid metal fast breeder reactor (base program) and fuel cycle R&D ($419.4/413.9) It is considered desirable to maintain present levels of effort in the LMFBR base program and fuel cycle R&D, except those aspects that are closely tied to near term demonstration should be reviewed for appropriate changes. Breeders with attendant reprocessing could have a high ultimate impact on energy supply security. Although the ultimate impact is post-2000, ERAB recommends that this base technology program must be maintained.

Clinch River Breeder Reactor ($172.0/$254.0) The ERAB believes that the construction of a breeder reactor demonstration at this time is not an urgent priority and thus, under current budget constraints, recommends that such a demonstration be delayed until a future time.*

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*See dissenting opinion and additional remarks in Appendix D.

APPENDIX B: BACKGROUND INFORMATION

CHRONOLOGY OF R&D PANEL MEETINGS[1] APRIL 30, 1980 TO NOVEMBER 5, 1981

1. Planning and Implementation

On April 30, 1980, Deputy Secretary John C. Sawhill requested ERAB to review the R&D programs in the Department. An initial review of the technology base in conjunction with the work the ER Director had underway would be helpful in contributing to the final decision on the FY 82 budget. ERAB approved the terms of reference and established a panel.

On June 7, 1980, the R&D Panel met to formulate questions and issues for Panel consideration, to develop outlines for Panel and Subpanel reports, and to discuss organizational matters. The Panel also approved an agenda for the first full-scale Panel and Subpanel organizational meetings to be held.

2. Technology Base Assessment and Detailed Program Reviews

On July 10, 1980, the Fossil R&D Subpanel met in Washington to receive briefings on fossil energy technology and R&D programs, review DOE's documents on technology base assessment, and discuss preparation of the initial draft input to final R&D Panel report.

On July 10th and 11th, 1980, the Conservation R&D Subpanel met in Washington, was briefed on conservation technology and R&D programs, and held initial discussions on Conservation Subpanel input into ERAB Technology Base Report.

On July 22, 1980, the Nuclear R&D Subpanel met in Washington for a summary of fact-finding briefings on nuclear technology and R&D programs. They discussed eight items pertaining to the technology base assessment of DOE's Nuclear R&D programs.

- Converter Reactor Systems
- Commercial Nuclear Systems
- Advanced Nuclear Systems
- Spent Nuclear Fuel
- Breeder Reactor Systems
- Advanced Isotope Separation Systems
- Nuclear Uranium Assessment
- Gas Centrifuge

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[1] All meetings were open to the public with notice in Federal Register.

On July 23, 1980, the Solar R&D Subpanel met in Washington for briefings on solar technology and R&D programs to review DOE documents on the technology base component of DOE's Solar Energy R&D program and to hold initial discussions on Solar Energy R&D Subpanel input into the ERAB Report.

On July 23, 1980, the Energy Research R&D Subpanel met in Washington for briefings on Basic Energy Sciences and other energy research programs and to review the technology base research support by the Office of Energy Research.

On July 29, 1980, the Environment R&D Subpanel met in Washington for discussions on the status of technology base assessment. Representatives from the research offices within DOE Office of Environment discussed highlights of their programs. Office of Technology Impacts discussed the complexity of doing good assessments stressing the problems of the data collection and management.

On July 29, 1980, the Resource Applications R&D Subpanel met in Washington for briefings on resource application programs to review DOE documents on the technology base component of DOE's Resource Applications R&D Program, and to hold initial discussions on Resource Applications R&D Subpanel's input into ERAB Technology Base Report.

On July 30th and 31st, 1980, the R&D Panel met in Washington for discussions on crosscutting issues and integration problems. Subpanel members discussed status of membership, information needs, plans to complete reports and planned for activities at La Jolla.

3. Interim Report on DOE Technology Base "R&D Needs in DOE"

On August 18th, 1980, the Board met as a whole, then divided into their individual subpanels to complete the initial phase of the study and report to the full ERAB during the course of the meeting.

On August 18th - August 22nd, 1980, the ERAB Summer Study meetings were held to develop an interim report, findings, conclusions and recommendations on the technology base assessment (TBA) study. The following seven (7) subpanels were involved

8/19/80 - R&D Integration Panel - La Jolla
8/19-21/80 - Energy Research R&D Subpanel - La Jolla
8/21/80 - Resource Applications R&D Subpanel - La Jolla
8/19/80 - Solar R&D Subpanel - La Jolla
8/18-20/80 - Environment R&D Subpanel - La Jolla
8/18-20/80 - Nuclear R&D Subpanel - La Jolla
8/19-21/80 - Fossil R&D Subpanel - La Jolla

In addition, ERAB conducted several in-depth technical reviews which were also used as a basis for the R&D priorities study. Specifically, ERAB conducted studies on: (1) Efficient Use of Energy (Conservation); (2) Fossil Energy; (3) Nuclear Energy; (4) Solar Energy; (5) Resource Applications; (6) Environment; and (7) Energy Research.

On August 22, 1980, the ERAB Board in La Jolla received the draft TBA report and approved it subject to incorporation of the members' revisions. The report was subsequently transmitted to the Secretary of Energy as an interim report on 9/5/80 (Research and Development Needs in the Department of Energy).

4. Methodology for Setting R&D Priorities

On December 19, 1980, the R&D Panel met in Washington to discuss a methodology for evaluating energy R&D priorities. Discussions were held on alternative approaches to implementing R&D Priorities Study proposed in Bill McCormick's "White Paper," suggesting the R&D needs exercise should be expanded to set overall priorities and trade-offs between R&D program areas based on consistent criteria.

On January 26, 1981, the R&D Panel met in Cleveland to dicuss the methodology for evaluating energy R&D priorities. Discussions were held to reveiw methodology for ranking priorities and structure of Panel/Subpanels. Other topics discussed were:

Membership, Technical Support Group
Definition of Criteria
Weight/Value Functions
Input, Value Judgments, and Outputs (by Subpanel)
Technology Lists
Schedule
Report Outlines

5. R&D Priorities and Study Report

At the February 5-6, 1981 ERAB meeting, discussions were held on the recent activities of the R&D Panel and alternate approaches. It was proposed that a number of subpanels could be formed to provide input on energy technologies and one which is to cover technology base and environmental considerations. Several energy product subpanels would then utilize input from the foregoing subpanels. The plan also included possible utilization of the MARKAL computer model developed by BNL.

At the July 9-10, 1981 ERAB meeting, John Foster, Chairman of the Panel, reviewed their past efforts beginning with the Interim Report transmitted to the Department last September, following an extensive effort culminating in the Summer Study meeting in August 1980.

TABLE IV-A

SUMMARY
R&D PRIORITIES
ELECTRIC SUPPLY PROGRAMS

RANK[1]	PROGRAM	PRIORITY[2]	President's FY82 Budget	ERAB Funding[2] Recommendations
1	Nuclear Waste Commercial (NE)	HIGHER	227.5	Same
2	Nuclear Waste Defense (DP)		390.0	Same
3	Conventional Reactor System (NE)	MEDIUM	68.0	More
4	Breeder Reactor Fuel Cycle R&D (NE)		26.1	Little Less
5	U E - Centrifuge (NE)[3]		64.5	Same
6	Liquid Metal Fast Breeder (NE) (Base Program)		387.8	Same
7	Solar Power Technology (CE)		19.4	Less
8	U E - Advanced Isotope Separation (NE)		85.2	Same
9	Magnetic Fusion (ER)	LOWER	456.1	Little Less
10	Light Water Breeder Reactor (NE)		58.0	Less
11	Uranium Resources Assessment (NE)		5.3	Same
12	Electric Energy & Storage Systems (CE)		47.5	Less
13	Hydropower (CE)		0.0	Zero
14	Clinch River Breeder Reactor (NE)		254.0	Less
15	Geothermal (CE)		46.3	Less
16	Magnetohydrodynamics (FE)		0.0	Zero

[1] Rankings represent consensus view of ERAB and should be interpreted with caution; the differentiation between any two consecutive programs is not necessarily significant.

[2] Priority reflects ERAB view of overall merit of program; funding recommendations relative to the President's budget request for FY82 reflect on Federal role.

[3] Excludes $695.3 million for centrifuge plant construction.

Light water breeder reactor ($60.2/$58.0) This program has the potential of extending the long-term supply of nuclear fuels. The ERAB agrees however that decreased funding for the LWBR may be warranted. The unattractive economics and the lack of industry interest are cited as reasons. Further reductions in funding are recommended.

Magnetic fusion ($391.0/$456.1) ERAB members agree on the long-term importance of this program and that the primary Federal role should be to continue to sponsor a joint program of the federal laboratories, industry and university scientific communities to determine if fusion can be practical.* The potential payoff is very large, but is much too far in the future for significant private sector support. There was agreement that a stretch-out of the program is possible if budgetary pressures demanded it, but maintenance of a substantial level of Federal R&D funding is judged to be essential. It is also recommended that an enhanced effort to examine the use of fusion for the breeding of nuclear fuels deserves consideration.

D. Non-nuclear Electric Programs**

Solar power technology ($112.1/$19.4) This technology area includes wind energy and Ocean Thermal Energy Conversion. (Photovoltaics is included under Solar Applications for Building in the conservation section.) Wind energy is regarded as the most technologically advanced and as having achieved commercial potential. Since there are no critical technical R&D problems preventing commercialization by industry, and since there is limited potential to be realized, the Board recommends less funding for this technology. In the case of OTEC, technical feasibility has been shown on a small scale, thus fulfilling the primary Federal role. The Board recommends that remaining funding should be used to facilitate the transition to industrial commercialization.

Hydropower ($2.4/$0.0) Technical success for small scale hydropower has been proved, and private industry is active (although it is noted that U.S. manufacturers of low-head hydro equipment are absent). Little, if any, R&D is needed; therefore, the Board recommends phase-out of funding. Investment tax and other credits are sufficient to commercialize this technology.

Magnetohydrodynamics ($66.5/$0.0) There are other technologies (such as combined cycle gas turbines) available for increasing the efficiency of large, central power generation stations that do not have the extreme temperature/erosion problems associated with the use of coal in MHD. For this reason the Board foresees little commercial demand for this technology and therefore concurs with the planned phase-out of this program. The Board recommends that existing government facilities be utilized by industry if they wish to pursue research in this area.

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*See Report on the DOE Magnetic Fusion Program, prepared by the Fusion Review Panel of ERAB, August 1980.

**Dispersed electric and co-generation technology, direct coal combustion, and fuel cell programs included in Section VI.

Geothermal ($153.6/$46.8) Strong agreement that funding should be decreased is predicated upon the fact that private industry should be undertaking the development of the part of the resource that appears economic, and is in fact doing so. The program is also seen as having low impact on national energy supply. If a Federal geothermal program is continued, emphasis should be on low temperature process heat and completing the ongoing hot dry rock program, not on geopressured energy resources, where the technical risk appears high or geothermal electric where industry is capable of solving the remaining problems.

Electric Energy and Storage ($109.8/$47.5) This program consists of two parts, R&D on electricity transmission and distribution and R&D on energy storage. R&D on electricity transmission and distribution is regarded as essentially the responsibility of private industry. As a result, there is agreement that the overall program should decrease in such a way that at least some results can be obtained from programs now at the point of yielding valuable data. R&D on energy storage, however, is regarded as important; this part of the program should be strengthened. The Board supports direct participation of Federal electricity producing and marketing agencies in the Electric Power Research Institute as a mechanism for supporting R&D on utility-related needs.

V. FUELS SUPPLY TECHNOLOGY

A. Introduction

Fuel supply technologies represent approximately 9% of the President's total FY 82 budget for energy supply. This sector of energy supply is not as highly regulated as the electric energy industry and has historically developed these supplies with private resources. In general, ERAB concludes that the more urgent technologies, such as enhanced gas and oil recovery, can have an early impact in the market but that the Federal role is significantly less since private industry will develop these sources. Conversely, as discussed in Chapter VII, on the Science and Technology Base, the Federal Government has important roles to play in environmental research on accumulation of CO_2 in the atmosphere and on acid rain. Either of these problems has the potential for substantially limiting expanded use of fossil fuels.

Table V-A provides a summary of the relative priorities and recommended funding levels discussed is this section.

B. Synthetic and Natural Gas

Enhanced Gas Recovery ($30.5/$10.2)* Enhanced gas recovery is given a medium priority with respect to urgency, benefit/cost ratio, supply security and a high priority with respect to technical and economic potential and health and environment. Government funding of the program should be decreased because the private sector is conducting adequate research and development in these areas. Only low level government funding is needed to assist in the funding of some private sector experiments by small companies and to maintain government awareness of what is being accomplished.

Surface Coal Gasification ($69.6/$53.4) Gasification is the most important step in the conversion of coals to synthetic gases and liquids by almost every process and possibly even in the conversion to electricity. While private sector efforts here and abroad are very extensive a continued DOE effort is well justified. Specifically, DOE gasification R&D should concentrate on (a) exploration of new process concepts; (b) R&D on the various auxiliary steps such as evaluation and preparation of gasifier feeds from U.S. coals and raw gas clean-up systems.

Most importantly R&D towards closing the gaps in the knowledge of environmental issues related to gasification is not only important but a most appropriate area for government research.

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*FY81 funding/FY82 President's request in million $ are shown in parenthesis.

TABLE V-A

SUMMARY
R&D PRIORITIES
LIQUIDS AND GAS SUPPLY PROGRAMS

RANK[1]	PROGRAM	PRIORITY[2]	President's FY82 Budget	ERAB Funding[2] Recommendations
1	Enhanced Oil Recovery (FE)	HIGHER	20.1	Less
2	Advanced Research and Environmental Control Technology (FE)	MEDIUM	94.5	Same
3	Enhanced Gas Recovery (FE)		10.2	Less
4	Coal Liquefaction (FE)		105.2	Less
5	Biomass Energy (CE)		20.5	Same
6	Surface Coal Gasification (FE)		53.4	Less
7	Mining R&D (FE)	LOWER	21.0	Less
8	In Situ Oil Shale (FE)		16.3	Less
9	Alcohol Fuels (CE)		10.0	Same
10	In Situ Coal Gasification (FE)		2.3	Less

[1] Rankings represent consensus view of ERAB and should be interpreted with caution; the differentiation between any two consecutive programs is not necessarily significant.

[2] Priority reflects ERAB view of overall merit of program; funding recommendations relative to the President's budget request for FY82 reflect on Federal role.

Since a very broad pilot and demonstration program is under way outside DOE (much of it abroad) the need for continued pilot plant operation is eliminated (example Bi-gas project). R&D elsewhere involves efforts on both air- and oxygen-blown gasifiers, thus a separate DOE program on air-blown (low-BTU) gasifiers appears redundant.

In view of the above, the Board concludes that a funding level somewhat below that proposed in the President's budget would be adequate.

In-Situ Coal Gasification ($10.0/$8.3) In-situ gasification has been attempted here and abroad for many decades but with limited success. One of the more interesting parts of this DOE program aims at gasification of coal in steeply dipping beds. Tests now underway should be completed during the next year. This is a unique application which can be evaluated at the end of the present program; if successful, further development can then be carried on by private sector sponsors with an interest in this type of coal deposit. With this exception, the in-situ coal gasification program has a low probability of a commercially viable success and can be phased out.

C. Petroleum and Synthetic Liquids

Enhanced Oil Recovery ($16.2/$20.1) ERAB gives enhanced oil recovery a very high priority with respect to technological and economic potential, benefit/cost ratio, urgency, supply security and health/environmental problems. However, the Board recommends that Federal funding, even though relatively small, be decreased. A small Federal expenditure can be justified only for some of the environmental research and to keep current with technical developments in the private sector. This recommendation stems from the considerable evidence that the larger energy companies have the ability, the know-how and the willingness to engage in sustained long-term R&D. Also, the oil companies have the financial strength to commercialize enhanced oil recovery processes without government financed demonstrations.

Coal Liquefaction ($277.0/$105.2) Commercially demonstrated coal liquefaction technology is currently available. This is based on the so-called "indirect" route. Large plants are now in operation abroad; a full size plant is under construction in the U.S. that will demonstrate the critical components. Although this plant is designed to produce synthetic natural gas, not liquids, some 4/5 of the total process sequence is identical with that required for liquids, specifically the gasification and gas purification. Improved processes for conversion of the resulting CO/H_2 mixtures to liquids are in the process of commercialization. Although the competitive route to coal-based liquids, namely direct hydrogenation, was once considered superior, it has not been practiced for 35 years and now requires an extensive R&D and demonstration program if it is to become competitive. This is desirable to avoid reliance on a single technology. DOE has been engaged in coal hydrogenation for over ten years and has advanced the art to the point where the private sector can evaluate the merit of direct hydrogenation. At the present time, there is no unanimity on any inherent advantage of direct hydrogenation over indirect liquefaction although it should be more thermally efficient in principle.

Outside of DOE activities, the Synthetic Fuels Corporation is even now considering support of several commercial scale liquefaction projects. All of the foregoing has made it possible for DOE to begin phasing out the large scale pilot and demonstration hydrogenation projects that were intended to close the gap between indirect and direct liquefaction of coal. This should be done in a manner protecting the major investments in these projects which include the 200 ton/Day Exxon Donor Solvent unit, the 250 ton/Day H-Coal Catalytic hydro unit and the 6000 ton/Day Solvent Refined Coal-I (SRC-I) demonstration project; in context with the latter it should be noted that real progress in coal hydrogenation (by any one of its many variants) will ultimately require a large commercial scale demonstration facility to resolve the difficult engineering problems. As a result, completion of the present design phase of SRC-I will serve to highlight the key difficulties on which future R&D should concentrate. It now appears that DOE will remain the key source of future R&D in direct liquefaction (hydrogenation). ERAB supports the continued effort in this area by DOE at the laboratory and small pilot plant scale with particular emphasis toward a broadening of the program to explore a wider range of technologies including 2-stage conversion based on carbonization or extraction with catalytic hydrocracking, new catalyst development, new solid/liquid separation.

DOE's intention to pursue development of improved indirect-liquefaction processes is not considered appropriate by ERAB, given the very extensive effort in the private sector; therefore, ERAB recommends elimination of this part of the liquefaction program.

In summary, ERAB recommends a reduced budget for coal liquefaction focusing on R&D in direct liquefaction area and particularly on R&D to resolve the environmental problems associated with this technology.

In-Situ Oil Shale ($32.2/$16.3) In-Situ Oil Shale is given a medium priority with respect to urgency, technical and economic potential, and benefit/cost ratio. Oil shale is given a high priority with respect to supply security. Since the rich shales will be used first and are concentrated in about a 600 square mile area in Colorado, special attention should be given to the environmental problems that will arise if commercial production rises to the level of one or two million barrels per day. Likewise, the infrastructure needed to support this level of production in such a small area needs study. The government has an important role to play with respect to both the environment and the infrastructure problems; the present funding should be focused on these problems.

The in-situ oil shale program is really only a minor variation of the process for exploiting the oil shale resource. Both subsurface retorting and surface retorting of shale is under active investigation by the private sector. Several companies are designing commercial facilities with the intention of producing oil from shale in the late 80's. There is no need for a government role in the development of the technology of recovery of oil from oil shale; Federal expenditures in this area should be eliminated.

D. Biomass and Solid Fuels

Biomass Energy* ($31.7/$20.5) and Alcohol Fuels ($18.0/$10.0) Both programs are given a high priority with respect to technical potential. Biomass is given a medium priority with respect to all other criteria. Alcohol fuels differ from biomass in that they have a lower priority with respect to economic potential, benefit cost/ratio, supply security and urgency. The Board recommends that these funding levels not be changed. Particular attention should be given to the conversion of lignocellulose to fuels.

Mining R&D ($40.2/$21.0) Coal mining is an area deserving of substantial attention and support of R&D by the Federal Government. Much of this work is conducted by agencies other than DOE.

The Board recommends that coal mining R&D be concentrated in one agency and that DOE/FE instead concentrate its efforts on innovative concepts, particularly for preparation of fine sized coal.

E. Advanced Fossil Energy Research

Advanced Research and Environmental Control Research ($95.3/$94.5)** The Board believes this program should be funded at its present level but with some redirection.

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*Report of the Biomass Panel of the Energy Research Advisory Board, November 1981.

**For FY82 budget request $67.1 for Advanced fossil R&D and $27.4 for environmental control technology development.

Advanced Research and Environmental Control Technology R&D (FE) includes, in addition to all exploratory R&D on coal conversion, research towards substitution of coal for oil and gas in direct combustion; this is an extremely important program since the vast majority of coal must be used as boiler fuel over the next several decades, both in existing and new units. Equally important is the development of improved emission control technology to reduce SO_x, NO_x and particulates in fluegas. The Board therefore urges that these parts of the Advanced Research and Environmental Control Programs be increased and given higher priority at the expense of other activities in this program. The remainder of the program is designed to provide technology base support to other fossil energy programs in such areas as materials, diagnostics, instrumentation, and applied research on new concepts and processes. This work is also important, but is longer range and should be closely coordinated with other technology base efforts.

VI. UTILIZATION AND CONSERVATION TECHNOLOGY

A. Introduction

Utilization and conservation technologies represent approximately 8% of the total FY 82 budget for energy research and development (see Tables III-C) divided 4% for utilization and 4% for conservation. The President's budget itself reflects severe budget cuts for these areas, up to 80% reductions over FY 81 in some cases.

Relative to their potential contributions to the solution of the near- and medium-term energy problems, there is an imbalance in the allocation of R&D funds between the conservation programs and those directed at supply. The budget needs a reordering of priorities to reflect better the opportunities that exist for efficiency improvements and the unique Federal role in conservation R&D.

ERAB's views on this point are reflected in the high priorities that members gave to conservation R&D: in the Board's ranking, three of the top five programs (and five of the top ten programs) of the entire Department's R&D projects were drawn from conservation/end-use R&D.

The priorities assigned to conservation and end use programs are summarized in Table VI-A.

B. Conservation Programs

Buildings and Community Systems ($53.0/$28.0)* ERAB ranked research on Buildings and Community Systems in the high priority range. Recognizing its importance to the energy problem as a whole and to the oil import problem particularly, the Board noted that private sector R&D in this area is rare because of the fragmented and undercapitalized nature of the industries involved. The efficiency improvements that can be made in existing structures are large, and no R&D capability exists within the remodeling or retrofit private sector. A Federal role is highly appropriate in this field; indeed, Federally-supported work at several of the National Laboratories, university centers, and elsewhere has been productive in product and design innovation and in transferring research results into the field quickly. The same is true of the consumer products work undertaken by these groups.

ERAB recommends that funding levels in this area be increased, emphasizing R&D that the private sector is not funding, while maintaining active R&D and technology transfer programs involving industry.

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*FY81 funding/FY82 President's request in million $ in parenthesis.

TABLE VI-A

SUMMARY
R&D PRIORITIES
CONSERVATION AND UTILIZATION

RANK[1]	PROGRAM	PRIORITY[2]	President's FY82 Budget	ERAB Funding[2] Recommendations
1	Coal Combustion Systems	HIGHER	38.8	Same
2	Buildings and Community Systems		23.0	More
3	Industrial Conservation		0.0	More
4	Transportation Conservation	MEDIUM	37.0	Same
5	Solar Applications for Buildings		34.7	Same
6	Heat Engines and Heat Recovery		15.5	Same
7	Multi-Sectors Conservation		17.5	Same
8	Fuel Cells		29.6	Same
9	Solar Applications for Industry	LOWER	44.0	Less

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[1] Rankings represent consensus view of ERAB and should be interpreted with caution; the differentiation between any two consecutive programs is not necessarily significant.

[2] Priority reflects ERAB view of overall merit of program; funding recommendations relative to the President's budget request for FY82 reflect on Federal role.

The Federal Energy Management Program will be one of the subjects of discussion by the Board's Conservation Panel. It is not an R&D program; its shortcomings appear to have little to do with budget levels.

Transportation Conservation ($102.1/$37.0) Transportation Conservation R&D ranks at the top of the medium priority group of R&D programs. ERAB recommends that the funding level remain the same.

R&D emphasis should shift from the automobile to the heavy freight truck sector. The vehicle propulsion technology development program should be transferred to industry in an orderly way; the market, driven by consumer preference and foreign competition, should determine the necessity for and the direction of this R&D, not the Federal government. Likewise, electric and hybrid vehicle R&D should be sharply reduced.* Alternative fuels utilization R&D should continue but with closer cooperation with potential ultimate users. The transportation systems utilization activities deserve firm support. This program includes work that the private sector either will not do on systems improvements or cannot provide candidly.

Multi-Sector Conservation ($25.8/$17.5) The Multi-Sector Conservation program historically has been made up of three elements: the small inventions program, the appropriate technology program, and the Energy Conversion and Utilization Technology (ECUT) program. The President's budget has eliminated the appropriate technology program, but kept portions of the other two activities.

Even though it is required by legislation, the inventions program deserves relatively less emphasis within the Department; money devoted to it could be more productively used in the ECUT program, particularly if that program is restructured along the lines the Board recommends.

ECUT now devotes a major share of its budget to research on understanding combustion phenomenon, heat exchanger technology, chemical processes, and materials. Much of this work has been cooperative with the using industries and appears to be bearing fruit.

ECUT management itself, working with a group of outside reviewers drawn from industry and elsewhere, has recommended that its research be principally directed toward work on chemical and physical processes that have generic applications in improving efficiency. ERAB concurs with augmenting ECUT's activities along these lines, using funds drawn from savings realized from the phasing out of the inventions and the appropriate technology program.

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*See dissenting opinion in Appendix D.

Overall, ERAB recommends that the funding level remain the same, but that virtually all the R&D money be used in a redirected ECUT program.

Industrial Conservation ($67.3/$0.0) Industrial Conservation ranked in the high category when compared with all other DOE R&D programs. ERAB recommends that this program be restored close to FY81 funding levels. Thus, ERAB recommends an increase in the proposed budget.

ERAB expressed concern that, although all industries have incentives to conserve energy, many of them lack the ability to conduct R&D either because of their fragmented industrial structure or because of historic failure to support research. This appears to be true of many small and medium sized businesses that, in the aggregate, consume large amounts of energy. Short-term, high-payoff R&D will not be conducted unless Federal leadership is given.

ERAB noted that many of the industrial conservation projects previously undertaken by DOE have been highly effective and have included cost recovery features for the Government. Continuity and continued skilled management are important features in the prior (and future) success of this R&D component.

C. Solar Programs

Solar Applications for Buildings ($224.9/$84.7) The Solar Applications for Buildings program was given a high priority within the medium range. ERAB believes the funding should remain the same, recognizing that the lower funding levels will stretch out the time frame for achieving lower cost photovoltaic electricity.

Photovoltaic (PV) R&D has approximately 75% of the budget in this program. PV and fusion are the major renewable options available for electricity generation if the CO_2 problem is found to be significant. Major cost reductions in PV have been achieved, and further reductions leading to an attractive economic potential appear highly likely if Federal funding is maintained. A separate report recently submitted to ERAB by the Solar Photovoltaic Advisory Committee of the Board provides detailed recommendations in this area. A halving of the budget for PV (as the President has recommended) will mean that development of low-cost PV will slow down, increasing the opportunities for foreign manufacturers to dominate the technology. Therefore, continued support of PV is important to maintain the momentum developed by this program. Emphasis should be placed on advancing those photovoltaic technologies required to achieve cost reductions in both module and cell areas as well as balance of system areas. Premature demonstration activities should be curtailed.

Continued Federal support for basic and applied research in passive solar technology will pay high dividends. The building industry is fragmented and has no institutions capable of supporting this R&D activity. R&D activity on active, building-by-building solar heating should be relinquished to private industry. Research on passive solar cooling deserves support, particularly cooling systems that are effective in humid sections of the country. Similarly, solar pond technology should be continued since it is highly promising.

Solar Thermal Applications for Industry ($138.3/$44.0) ERAB recommends reduced overall funding with increased emphasis on selected elements within this medium priority program. High temperature collectors (concentrators and receivers) deserve increased support because of their great versatility in application and the lack of industrial R&D. Dish technology development should remain at the module level until technical and economic feasibility has been attained with several different modules.

Areas to be considered for reduced Federal support include those technologies where significant industrial interest is expressed already, specifically development in heliostat and external steam receivers, operation of Solar One and Shenandoah, and technology for process heat applications.

D. Other End-Use Technologies

Direct Coal Combustion Systems ($37.4/$38.8) No other direct combustion alternative exists that eliminates the need for scrubbers and is close to commercialization. Hence, ERAB recommends that the direct coal combustion systems program be continued with the same level of funding, although some redirection of emphasis is appropriate.

Atmospheric fluidized bed combusters for industrial applications are ready to move into the commercial market in configurations supported by the Federal Government in the past; further funding is no longer needed and should support instead advanced combustors that appear capable of burning with lower SO_X and NO_X emissions.

Research on pressurized fluidized bed combustors for utility and industrial applications is longer term with a promise of providing multi-fuel capabilities in, for example, cogeneration applications. In addition, advanced combustion concepts and alternative fuel utilization research may provide environmental or fuel substitution advantages.

Fuel Cells ($32.0/$23.6) Fuel cells represent an undeveloped technology with important environmental advantages. Although both the electric and gas industries are supporting research, some Federal support is essential for its continuation. ERAB recommends no change in the level of funding.

During FY 82, the phosphoric acid fuel cell technology will be tested in a 4.8 MW plant under construction in New York City; extension of the program should be assured to include testing of coal-derived fuel (methanol) and possibly shale liquids. The solid oxide fuel cell, while beyond the proof-of-principle stage. still requires subsystem development. In addition, the molten carbonate fuel cell with its high susceptibility to sulphur catalyst contamination and other high risk advanced technologies deserve continued support.

Heat Engines and Heat Recovery ($31.8/$15.6) ERAB recommends no change in funding for the heat engine program, but some redirection of effort is needed. The coal fueled diesel engine has little chance of economic success; its funding should be shifted to development of high temperature gas turbines. Since high risk technology for high efficiency central and dispersed power systems is the goal of this program, a major effort directed at higher efficiency/higher temperature gas turbines, the sine qua non for an efficient combined cycle, coal-fired power system, is more appropriate.

The heat recovery program supported with carry-over funds from FY 81 should be continued with additional funding requested for continuation of uranium enrichment plant heat recovery projects in FY 83.

VII. SCIENCE AND TECHNOLOGY BASE

A. Introduction

It has long been agreed that the Federal Government must play a primary role in the maintenance of research programs that contribute to new understanding and to expansion of the U.S. technology base. Generally, the activities sponsored by the DOE for this purpose represent an appropriate set of programs for maintaining and expanding the energy technology base, the body of knowledge and know-how upon which the nation must rely for implementation of our overall objectives in the energy field.

The program elements in DOE that constitute the science and technology base fall largely into two categories: general science and energy supporting research. It is the assessment of the Energy Research Advisory Board that both components are appropriate, represent research of high quality and scientific potential and, with minor exceptions, especially in basic and biological energy sciences, that the President's proposed budget for FY 82 calls for an adequate allocation of funds for these programs or allows for adjustments and reallocations that can assure continued progress towards the Nation's goals under the overall constrained budgetary circumstances.

Table VII-A summarizes the relative priorities and funding recommendations. It should again be noted that a separate set of criteria were used to evaluate these programs; thus, the rankings are not directly comparable with the R&D programs discussed in prior sections of this report.

B. General Science

These programs in General Science support the Nation's effort in high energy physics, nuclear physics, general life sciences, nuclear medicine, and the preparation of certain radioactive and heavy isotopes for scientific and commercial uses in a myriad of endeavors. Historically and by interagency agreement, DOE is the lead agency for these national programs that are of long-range importance in the energy effort but, in addition, have broader significance for continued progress in many commercial developments, in space, in defense, and in health-related fields. These basic research programs are sometimes characterized as a "national trust." ERAB proposes no change in these missions and no modification in present budgetary projections for them.

TABLE VII-A

SUMMARY
R&D PRIORITIES
SCIENCE AND TECHNOLOGY BASE

RANK[1]	PROGRAM	PRIORITY[2]	President's FY82 Budget	ERAB Funding[2] Recommendations
1	Materials Sciences	HIGHER	112.1	More
2	Climate and CO_2 Research		16.7[3]	More
3	Chemical Sciences		73.9	More
4	Biological & Environmental Research		153.8[3]	More
5	Biological Energy Sciences		9.4	More
6	Nuclear Medicine		50.5	Same
7	High Energy Physics		392.7	Same
8	University Research		10.6	More
9	Environment and Safety		49.6	Same
10	Engineering, Math & Geosciences		32.3	Same
11	Nuclear Physics		122.9	Same
12	Nuclear Sciences	MEDIUM	37.7	Same
13	Advanced Energy Projects		2.2	Same
14	Technology Assessments	LOWER	3.0	Same

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[1] Rankings represent consensus view of ERAB and should be interpreted with caution; the differentiation between any two consecutive programs is not necessarily significant.

[2] Priority reflects ERAB view of overall merit of program; funding recommendations relative to the President's budget request for FY82 reflect on Federal role.

[3] The Biological and Environmental Research Program includes Climate and CO_2 Research with a total budget of $170.5 M.

High Energy Physics ($348.2/$392.7)* This program is the Nation's principal effort to explore the fundamental components and interactions of matter. It depends upon unique, large scale, high cost experimental facilities that are used by laboratory and university scientists to probe ever deeper into the structure of matter and the universe. Support of such research is a Federal responsibility since it is not expected to have commercial significance, although many commercial applications have arisen from technology developed through this program. Some university scientists who work at DOE facilities are supported by NSF; a joint planning process is used to ensure coordination. Support at about the present level will continue a longstanding U.S. commitment toward excellence in this field of science.

Nuclear Physics ($109.2/$122.9) The Nuclear Physics Program addresses the fundamental interactions and structure of the atomic nucleus. It develops and uses unique large-scale facilities at national laboratories and universities with a particular emphasis on heavy ion research and meson interactions with matter. Such research is long-range and would not be carried out without Federal support. Joint planning with NSF, the only other sponsor in this field, is intended to provide a balanced national effort. Support should be continued at about the same level-of-effort.

General Life Sciences and Nuclear Medicine ($45.9/$50.5) This combination of long-term biological research and unique medical application of nuclear techniques is clearly of value to the public and is unlikely to be undertaken by private industry. The genetic and cellular research provides a fundamental scientific underpinning for the more applied Biological and Environmental Research program while the nuclear medicine component exploits unique DOE facilities for the production, testing and application of radioisotopes. The current level-of-effort seems appropriate.

C. Energy Supporting Research

The Energy Supporting Research Programs of DOE are intended to expand the nation's technological alternatives by explorations in chemistry, materials science, biology, engineering and mathematics, geosciences and environmentally-related fields of health. Particularly important is the Climate and CO_2 research program since CO_2 accumulation may prove to be a "show-stopper" in terms of expanded fossil (but not biomass) energy alternatives. Additionally, the problem of acid rain is suggested as an important new area for emphasis by DOE.

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*FY81 funding/FY82 President's request in million $ are shown in parenthesis.

Materials Sciences ($95.2/$112.1) This program includes long-range research in solid state physics, materials chemistry, metallurgy and ceramics that is intended to provide a knowledge base that will lead to improved economics and performance of energy systems. Materials problems plague many energy production and conversion systems; a strengthening of this program would be a sound long-term investment since it addresses such important generic areas as high temperature alloys, corrosion, radiation damage and the physics and chemistry of surfaces. Increased operating costs of major facilities (such as neutron sources) has squeezed this program in recent years. Increased funding is recommended.

Climate and CO_2 Research ($12.9/$16.7*) ERAB members are in strong agreement on the importance of this program due to its long-term significance for public policy toward the use of fossil fuels. Although the predicted effects of increased CO_2 in the atmosphere occur well in the future, an intensified research effort is needed now in order to ensure that better information will be available for future decision making. The Federal Government clearly has the principal responsibility for research in this area; an increased effort is recommended.

Chemical Sciences ($69.0/$73.9) ERAB members are in general agreement that this program should be increased. The research supported is long-range and fundamental and addresses processes, interactions, and chemical transformations in liquids, gases and plasmas. Potential applications include developments ranging from new chemical catalysts for coal liquefaction to improved knowledge of combustion in automotive engines. Increased support in this area has recently been recommended by a detailed study of the Committee on Chemical Sciences of the National Research Council; ERAB concurs with that view.

Biological Energy Research ($7.7/$9.4) This program is designed to investigate the fundamental processes underlying plant biomass productivity and conversion of biomass to other materials for use as fuels or chemicals. ERAB members were generally in agreement that this program should be increased due to the long-term potential contribution from biomass and the small size of the present effort.

University Research ($11.8/$10.5) This program is primarily oriented toward improving the quality and quantity of scientific personnel in energy-related areas. This is clearly an area appropriate for Federal concern; an expanded program is recommended due to the modest level of the present effort.

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*Funded under Biological and Environmental Research. Excluded from Basic Energy Sciences budget.

Engineering, Math and Geosciences ($25.9/$32.3) Each of these areas of science, engineering, and mathematics is pertinent to energy and should be addressed by DOE programs. For example, the programs of the Atomic Energy Commission (AEC) were the first of the high technologies to rely effectively on computer modeling. For this reason, the AEC and its successor agencies, including DOE, have been the leading government agencies in supporting R&D in these areas. The DOE support should be targeted carefully toward those topics that are most obviously relevant to energy and correspond to scientific information needed by other DOE programs. In view of the importance of this effort, the present overall program is minimal.

Nuclear Sciences ($33.7/$37.9) This program includes research in low energy nuclear physics, actinide element chemistry and compilation of nuclear data relevant to the needs of the fission and fusion programs. It also supports the production, using unique federally funded facilities, and distribution of isotopes for medical and industrial use. The present funding level should suffice.

Advanced Energy Projects ($6.7/$8.2) This program identifies and tests the scientific feasibility of novel energy concepts. Particular attention is paid to proposed approaches that do not fit neatly in the scope of other DOE programs with the expectation that concepts that prove scientifically feasible and appear economically promising will be subsequently developed by other DOE programs or by private industry. In the view of ERAB, this program provides a worthwhile safety valve to ensure that promising ideas will not be ignored. The program should not be allowed to grow unduly at the expense of the higher priorities that have been identified, but should remain at about present funding levels.

Technical Assessment Projects ($9.5/$3.0) This program provides support for independent, objective analyses of R&D programs and needs and contributes to the overall planning effort of the Department. Present funding levels seem sufficient; expansion in this area is not needed.

D. Environmental Research

Biological and Environmental Research ($168.4/$170.5) This program investigates the potential human health and environmental impacts of new energy technology. It involves identifying the substances produced by energy systems, including such phenomena as acid rain; tracing their movement through air, water and land; and assessing their effects on humans and other living systems. Such research is clearly a Federal responsibility. It could not and should not be entrusted to private industry due not only to the long-term generic character of the work but also to the need for credibility and comprehensiveness. Certain unique long-baseline programs in ecology and radiation effects can only be carried out under Federal auspicies. This program has been about level or reduced in recent years; an increase in funding is warranted.

ERAB recommends a change in program emphasis with a major, urgent concentration of effort to resolve the acid rain problem. The ability to increase the use of coal, particularly the high sulfur coals in the Eastern U.S., depends on a far better understanding of the causes as well as the impacts of acid rain. The information currently available raises as many questions as it seems to answer regarding the relation of coal-based emissions to the occurrence of acid rain. Thus, a major effort by DOE is in order to assure that future increased use of coal remains an acceptable option.

Environment and Safety ($48.5/$49.6) This program is designed to assess information concerning the environmental impacts of energy development, the safety impacts of various technologies, and the health and safety aspects of DOE and contractor facilities. Clearly, DOE must be concerned with the safety both of energy systems and of the facilities for which it is responsible.

E. Federal Role and the Energy Technology Base

The distribution of performer efforts for the DOE technology base program (government laboratories, universities, or industry) deserves reexamination and both ERAB and DOE have embarked upon studies that will culminate in recommendations on this score within a few months.

The high Federal role in these efforts is worthy of emphasis if the Nation's long-run energy needs are to be met. Industry conducts and will continue to conduct basic and applied research to serve its short-term economic needs, but interim economic incentives will always result in disjointed efforts from the national perspective. Only the Federal Government can assure a balanced approach for the longer run. The DOE research program also contributes to the technology base relevant to other national missions since advances in underlying knowledge can be widely applicable.

Finally, the reluctance of Congress, until now, to appropriate funds for the support of economic and social science studies relevant to energy demand usage and conservation has resulted in an incomplete DOE program for its technology base. ERAB again endorses the authorization and implementation of such programs in DOE.

VIII. CONCLUSIONS AND RECOMMENDATIONS CONCERNING ENERGY R & D PRIORITIES

A. Overall R & D Program Priorities

Table VIII-A summarizes the results of the Board's evaluations of the four major energy R&D sectors: Electric supply, liquid and gas supply, conservation and utilization, and technology base. There are a number of electric-supply-related R&D programs that, for a variety of reasons, are of low priority and whose funding should either be substantially reduced or terminated. This reflects, in part, the Board's view that although no "correct balance among energy forms and resources can be defined a priori," R&D for electric supply technology is receiving a larger proportion of funding than the present and projected share of electricity in our national energy supplies.

The Board concluded that the overall Federal funding level in the liquid and gas R&D supply was higher than needed. This view results from the belief that the oil and gas industries are in a good position to take advantage of energy R&D opportunities and that the Federal Government role should be primarily focused on longer-term, higher-risk, applied research and development. It should not directly support costly demonstrations or large pilot plant projects (except as funded by loan or price guarantees through DOE and later under the Synthetic Fuels Corporation). However, great care should be taken in phasing out existing Federal R&D programs to insure technology transfer to the private sector.

In the conservation and end-use utilization area, the Board concluded that funding should be increased. The Board recognizes that higher energy prices have resulted in substantial reductions in energy demand and that this process is likely to continue. However, private enterprise in the buildings sector and, to a large degree, in the industrial sector is unlikely to do all the R&D needed. The Board believes that funds allocated to R&D in these two sectors should be increased. Such increases, combined with other ERAB recommendations, would increase the total allocation to the utilization and conservation technologies.

With regard to technology base programs, it was the Board's view that the funding for such programs should not be decreased and in certain areas should be increased. This stems from the Board's belief that, of all the sectors for energy R&D funding, the technology base programs are less likely to attract industry support; therefore, the Federal Government's role is greatest. Continued and increased support in the technology base programs offers the best chance for substantial technological break-throughs and improvements.

TABLE VIII-A

RELATIVE PROGRAM RANKING

	Electric Supply		Fuel Supply		Conservation & Utilization		Science and Technology Base[1]	
Priority	Program	Funding	Program	Funding	Programs	Funding	Programs	Funding
HIGHER								
							Materials Sciences	More
							Climate & CO_2 Research	More
							Chemical Sciences	More
	Commercial Nuclear Waste	Same						
							Biol/Environmental Research	More
							Biological Energy Sciences	More
					Coal Combustion	Same	Nuclear Medicine	Same
	Defense Nuclear Waste	Same			Buildings/Community Systems	More	High Energy Physics	Same
					Industrial Conservation	More	University Research	More
			Enhanced Oil Recovery	Less				
							Environment & Safety	Same
							Engineering/Math/Geosciences	Same
							Nuclear Physics	Same
MEDIUM	Conventional Reactors	More	Advanced Technology	Same	Transportation Conservation	Same		
			Enhanced Gas Recovery	Less	Solar Applications/Bldgs	Same		
	Breeder Fuel Cycle R&D	Little Less						
							Nuclear Sciences	Same
	Centrifuge	Same						
	LMFBR	Same						
					Heat Engines/Heat Recovery	Same		
			Coal Liquefaction	Less				
							Advanced Energy Projects	Same
	Solar Power Technology	Less						
					Multi-Sectors Conservation	Same		
	Advanced Isotope Separation	Same						
					Fuel Cells	Same		
			Biomass Energy	Same				
			Surface Coal Gasification	Less				
LOWER			Mining R&D	Less	Solar Applications/Industry	Less		
	Magnetic Fusion	Little Less	In-Situ Oil Shale	Less				
							Technology Assessments	Same
	Light Water Breeder	Less						
	Uranium Resource	Same						
	Electric Energy/Storage	Less						
	Hydropower	Zero						
	Clinch River Breeder	Less						
	Geothermal	Less						
			Alcohol Fuels	Same				
			In-Situ Coal Gasification	Less				
	Magnetohydrodynamics	Zero						

[1] Science and technology base programs were evaluated by a different set of criteria from the RD&D programs and are not directly comparable to them.

The remainder of this Chapter summarizes the conclusions and recommendations* of the Board in each of the Energy R&D program areas.

B. Electric Supply R&D Programs

With regard to Electric Supply R&D Programs, the major conclusions of the Board are as follows:

1. Continued emphasis is needed to complete the development and commercialization of light water nuclear power reactors in the U.S. A commitment has been made by this Administration to nuclear power. It has a significant role in the nation's energy mix; continued Federal support at this time is necessary. Hence, the Board recommends that continued funding be given to conventional reactor systems and safety, waste disposal programs (particularly accelerated demonstration), and uranium enrichment.

2. With respect to the liquid metal breeder reactor, research and development should be continued in order to maintain the capability for demonstrating breeder technology in the future. However, construction of a demonstration plant in the early 1980s is not an urgent national priority. Sufficient coal and uranium supplies exist to satisfy projected levels of electrical demand for at least 40 years and possibly well beyond. For these reasons, the panel recommends continued research and development on the liquid metal breeder reactor, as well as other breeder concepts, but that demonstration of breeder technology be delayed until a future time.**

3. With respect to fusion, ERAB members agree on the long-term importance of this program and that the primary Federal role should be to continue to sponsor a joint program of the Federal laboratories, industry and university scientific communities to determine if fusion can be practical. The potential payoff is very large, but is much too far in the future for significant private sector support. There was agreement that a stretch-out of the program is possible if budgetary pressures demanded it, but maintenance of a substantial level of Federal R&D funding is judged to be essential. It is also recommended that an enhanced effort to examine the use of fusion for the breeding of nuclear fuels deserves consideration.

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*All funding recommendations are relative to the President's FY82 budget request.

**See dissenting opinion and additional remarks in Appendix D.

4. Finally, there are several electric programs for which funding should be reduced or eliminated (such as solar power technology, light water breeder reactors, electric transmission systems, geothermal, magnetohydrodynamics, and hydropower) due to their relatively small contribution to electric supplies in comparison with other programs.

C. Liquid and Gas Supply R&D Programs

With regard to Liquid and Gas Supply R&D Programs, the major conclusions of the Board are as follows:

1. With respect to enhanced oil and gas R&D recovery programs, the ERAB concluded that the U.S. oil and gas industry has sufficient resources and financial incentives to develop these technologies without substantial government assistance. The Board concluded that, even though these programs are important from the standpoint of urgency and energy security, the Federal R&D role should be minimal with less Federal funding needed.

2. With regard to coal liquefaction and coal gasification, it was concluded that large-scale demonstration projects involving substantial cost-shared Federal outlays are not necessary or appropriate considering the financial guarantees (e.g., loan guarantees, price guarantees) that are available from DOE and the Synthetic Fuels Corporation. The major Federal effort in synthetic fuels research and development should be directed at innovative concepts at the laboratory and small pilot-plant scale with particular emphasis toward exploring a wider range of technological options with potential for significant efficiency and cost improvements. The Board recommends a reduced budget for DOE's cost-shared projects at the large pilot plant and demonstration-plant scale.

3. With respect to in-situ oil shale recovery, the Board recommends a decrease in funding based on the fact that several major oil companies have in-situ shale projects that do not involve Federal assistance.

4. The funding level for R&D directed at producing liquids and gases from biomass and the production of alcohol is at an appropriate level.*

5. Continuing increases in the price of conventional oil and gas suggest that the time when coal and oil shale will be economic sources of oil may be near at hand. This situation is stimulating the private sector to consider some commercial operations by 1990. ERAB concludes that

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*See ERAB reports on Biomass and Alcohol Fuels.

the private sector can be expected to carry out important actions that justify a lessening of DOE research in these technologies. However, it is recommended that DOE accelerate its research in environmental problems and infrastructure problems associated with the commercialization of these technologies.

6. The bulk of the coal produced for the next several decades will be used directly as boiler fuel, both in existing and new units, reducing dependence on oil and gas for this purpose. But improved emission control technologies to reduce SO_x, NO_x and particulate emission in flue gases will be essential to the success of this effort. ERAB therefore urges that this part of the Advanced Research and Environmental Control Technology (FE) programs be increased and given higher priority at the expense of the other activities in this program.

D. Conservation and Utilization R&D Programs

With regard to Conservation and Utilization R&D Programs, the major conclusions of the Board are as follows:

1. The overall level of Federal R&D funding for conservation and improved utilization programs is too low in view of their potential for energy improvements and the inability of many important energy-consuming sectors to conduct R&D. Moreover, Department-wide, the balance between supply oriented R&D and conservation R&D is too heavily weighted toward the supply side.

2. The Board concluded that R&D in Buildings and Community Systems needs increased funding in view of the large amount of energy consumed in this sector and the lack of private sector institutions able to undertake building systems R&D. This is particularly true in the case of the important retrofit technologies.

3. R&D in the transportation sector should be redirected away from its present heavy emphasis on automobile engines and toward the heavy freight truck sector. The phase out should include a sharp reduction in work on the electric and hybrid vehicle.* Transportation systems utilization activities deserve support. Overall, funding levels in this area should remain the same.

4. Funding for the Multi-Sector Conservation program should remain the same and should be concentrated on work in the Energy Conversion and Utilization Technology program (ECUT).

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*See dissenting opinion in Appendix D.

5. Funding for the Industrial Conservation programs should be restored to approximately the level in FY81. Many industries have no capacity for private sector R&D and that the close cooperation with users that characterized this program deserves continuation.

6. Solar Applications for Buildings should be redirected slightly to emphasize passive heating and cooling. Solar pond and ice cooling technology should be continued since it is highly promising.

7. Funding for Solar Thermal Applications for Industry deserves slightly lower levels of support with redirection toward high temperature collector and dish technology development.

8. Funding for direct coal combustion systems (a high priority program), fuel cells, and heat engines and heat recovery should remain at the same levels.

E. Science and Technology Base Programs

The Board recommends increased Federal funding in a number of program areas. The Board would give particular emphasis to environmental and health-related research, clearly important from the standpoint of understanding and evaluating the long-term impact of the introduction of new energy technologies. Of particular importance are the CO_2 and acid rain issues. As previously indicated, the panel believes that the science and technology base programs should have a relatively higher Federal priority because of the lower likelihood that industry would provide adequate funds for such basic and applied research.

F. General Conclusions and Recommendations

1. Serious attention must be paid to several related environmental issues. First, development of nuclear waste disposal technologies and control technologies in the Advanced Research and Environmental Control Technology Program are necessary for environmentally sound implementation of present and future technologies. Second, several of the programs in the science and technology base are essential if a proper energy mix is to be employed. These include the acid rain program, the climate CO_2 program, and Health and Environmental Research.

2. Our energy system is a web of machines and people; the current budget is focused on machines. Consideration should be given to research in social areas, to prepare for rapid energy development in certain portions of the country and to help transfer conservation technologies for the industrial and residential sectors.

APPENDIX A

Department of Energy
Washington, D.C. 20585

AUG 13 1981

Mr. Louis H. Roddis, Chairman
Energy Research Advisory Board
110 Broad Street
Charleston, S. C. 29401

Dear Lou:

The Department of Energy has invested heavily over the past several years in research and development on a wide range of energy alternatives. DOE now plans to increase emphasis on long-term, high-risk, and potentially high-payoff R&D programs. As such, it is timely to review our R&D priorities and to make some hard choices on which programs to pursue vigorously and which to deemphasize based on a realistic appraisal of both our energy options and energy needs for the foreseeable future. I would appreciate the advice of the Energy Research Advisory Board on these matters and particularly the Board's recommendations on overall Federal energy R&D priorities.

This effort can be based on the Board's broad knowledge of DOE programs and especially on the recent R&D panel activities to review the energy technology base and to develop criteria and methods for assessing priorities. Your terms-of-reference should include review and recommendations on the following concerns:

- The relative merits of each major R&D program with respect to such criteria as the technical and economic potential, urgency and lead time required, benefits and costs of Federal funding, contribution to energy security, health and environmental risks, and the appropriate Federal role;
- The appropriate R&D funding balance between electric power supply, fuels supply, conservation, and technology base program areas;
- The appropriate program orientation and balance between research, development, and demonstration activities;
- The strategic R&D objectives for the near-, mid-, and long-term.

Your thoughts on these matters would be particularly useful by November 16, 1981, to assist the Secretary and myself with our reviews of the DOE Sunset Report and the FY83 budget. However, I regard this as a continuing and important assignment for the Board and would also appreciate your recommendation on the next steps. Specifically, you should consider what efforts both ERAB and the Department should undertake toward improving our overall R&D planning, management, and evaluation processes and decisions. I will personally look forward to your report and hope to meet frequently with you and the Board as the study progresses.

Sincerely,

K

W. Kenneth Davis
Deputy Secretary

Appendix A

THE SECRETARY OF ENERGY
WASHINGTON, D.C. 20585

April 30, 1980

Dr. Solomon J. Buchsbaum
Executive Vice President
Customer Systems
Bell Laboratories
Crawford Corner Road
Holmdel, New Jersey 07733

Dear Dr. Buchsbaum:

Research and development to increase the supply, conversion efficiency and conservation of energy is vital to our national interest. I am particularly concerned about the adequacy of the Department's efforts in this area. The Department is presently undertaking a review of the technology base component of our R&D programs under the leadership of the Director of Energy Research with a view toward improving their effectiveness. I would appreciate the participation of ERAB in this process in order to give us the benefit of external views on the adequacy of these programs.

There are some broad concerns that need to be addressed:

- o The adequacy of the research underpinning for technology development programs.
- o Possible gaps or duplications of effort.
- o The balance among research performers (universities, laboratories, industry).
- o Significant R&D opportunities that our programs may be missing.

Obviously, a complete review of this whole area would be a lengthy and complex task and I view this as a continuing effort through which ERAB might help the Department. In the shorter term, an initial review of the technology base in conjunction with the work Ed Frieman already has underway could be helpful in contributing to our final decisions on the FY 1982 budget if it could be completed by the end of the summer. I hope that ERAB can devote a portion of its summer study to this task.

Sincerely,

John C. Sawhill
Deputy Secretary

APPENDIX B: BACKGROUND INFORMATION

CHRONOLOGY OF R&D PANEL MEETINGS[1] APRIL 30, 1980 TO NOVEMBER 5, 1981

1. Planning and Implementation

On April 30, 1980, Deputy Secretary John C. Sawhill requested ERAB to review the R&D programs in the Department. An initial review of the technology base in conjunction with the work the ER Director had underway would be helpful in contributing to the final decision on the FY 82 budget. ERAB approved the terms of reference and established a panel.

On June 7, 1980, the R&D Panel met to formulate questions and issues for Panel consideration, to develop outlines for Panel and Subpanel reports, and to discuss organizational matters. The Panel also approved an agenda for the first full-scale Panel and Subpanel organizational meetings to be held.

2. Technology Base Assessment and Detailed Program Reviews

On July 10, 1980, the Fossil R&D Subpanel met in Washington to receive briefings on fossil energy technology and R&D programs, review DOE's documents on technology base assessment, and discuss preparation of the initial draft input to final R&D Panel report.

On July 10th and 11th, 1980, the Conservation R&D Subpanel met in Washington, was briefed on conservation technology and R&D programs, and held initial discussions on Conservation Subpanel input into ERAB Technology Base Report.

On July 22, 1980, the Nuclear R&D Subpanel met in Washington for a summary of fact-finding briefings on nuclear technology and R&D programs. They discussed eight items pertaining to the technology base assessment of DOE's Nuclear R&D programs.

- Converter Reactor Systems
- Commercial Nuclear Systems
- Advanced Nuclear Systems
- Spent Nuclear Fuel
- Breeder Reactor Systems
- Advanced Isotope Separation Systems
- Nuclear Uranium Assessment
- Gas Centrifuge

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[1] All meetings were open to the public with notice in Federal Register.

On July 23, 1980, the Solar R&D Subpanel met in Washington for briefings on solar technology and R&D programs to review DOE documents on the technology base component of DOE's Solar Energy R&D program and to hold initial discussions on Solar Energy R&D Subpanel input into the ERAB Report.

On July 23, 1980, the Energy Research R&D Subpanel met in Washington for briefings on Basic Energy Sciences and other energy research programs and to review the technology base research support by the Office of Energy Research.

On July 29, 1980, the Environment R&D Subpanel met in Washington for discussions on the status of technology base assessment. Representatives from the research offices within DOE Office of Environment discussed highlights of their programs. Office of Technology Impacts discussed the complexity of doing good assessments stressing the problems of the data collection and management.

On July 29, 1980, the Resource Applications R&D Subpanel met in Washington for briefings on resource application programs to review DOE documents on the technology base component of DOE's Resource Applications R&D Program, and to hold initial discussions on Resource Applications R&D Subpanel's input into ERAB Technology Base Report.

On July 30th and 31st, 1980, the R&D Panel met in Washington for discussions on crosscutting issues and integration problems. Subpanel members discussed status of membership, information needs, plans to complete reports and planned for activities at La Jolla.

3. Interim Report on DOE Technology Base "R&D Needs in DOE"

On August 18th, 1980, the Board met as a whole, then divided into their individual subpanels to complete the initial phase of the study and report to the full ERAB during the course of the meeting.

On August 18th - August 22nd, 1980, the ERAB Summer Study meetings were held to develop an interim report, findings, conclusions and recommendations on the technology base assessment (TBA) study. The following seven (7) subpanels were involved

8/19/80 - R&D Integration Panel - La Jolla
8/19-21/80 - Energy Research R&D Subpanel - La Jolla
8/21/80 - Resource Applications R&D Subpanel - La Jolla
8/19/80 - Solar R&D Subpanel - La Jolla
8/18-20/80 - Environment R&D Subpanel - La Jolla
8/18-20/80 - Nuclear R&D Subpanel - La Jolla
8/19-21/80 - Fossil R&D Subpanel - La Jolla

On August 13, 1981, Deputy Secretary Kenneth Davis requested advice of the Energy Research Advisory Board on the R&D priorities and the Board's recommendations on the overall Federal energy R&D priorities.

The Panel was in the process of developing a methodology which would assist in assigning priorities to the nation's energy R&D programs, and would also help to illuminate the appropriate role of the Federal Government in these programs. For the purposes of the R&D priorities study, the R&D Panel would consist of all the members of ERAB with an Executive Committee appointed by the Chairman to include John Foster (Chairman, R&D Panel), William McCormick (Vice Chairman, R&D Panel), Lou Roddis (Chairman of ERAB), and Ivan Bennett (Vice Chairman of ERAB). Whether additional Panel members would be appointed would be decided at a later date; previous subpanels to the R&D Panel were dissolved.

At the September 2-3, 1981 ERAB meeting, the Chairman reported on the progress and current status of the R&D study and noted the August 13 letter request from the Deputy Secretary which sets the framework for it. The Deputy had asked that the report be completed by mid-November. John Foster, R&D Panel Chairman, described in detail the activities of the Panel, the methodology they were applying, and the evaluation forms each member will be asked to complete and return for collation. He urged each member to include any narrative comments along with their program evaluations which would serve to explain any particular rating made by a member and serve as a basis for drafting the report.

A detailed discussion then followed among all ERAB members in an attempt to establish a uniform basis among them all for their responses. These responses were discussed at a special meeting of the Panel on September 24. Preliminary results were sent to members on October 1. ERAB members submitted respective subsection drafts October 15, and a draft of the report was sent to ERAB members by October 30. The final review took place at the ERAB meeting on November 4-5.

On September 24, 1981, the R&D Panel met in Washington to discuss a number of cases in which overall programs were not highly rated, but individual aspects of subprograms of the major program were essential. The Panel concluded that considerations for subprograms of the major programs, particularly those involving subprogram funding recommendations, should be highlighted by discussion in the narrative portion of its report.

The initial results of the prioritization study were discussed at the Energy R&D Panel Meeting held September 24, 1981, in Washington, DC. At that meeting consensus recommendations were reached concerning funding where no consensus had resulted from the raw data evaluation. It was recognized that the final priority ratings would be the result of an evaluating process.

TABLE 8-1

ENERGY R,D&D PROGRAM BUDGET SUMMARY

	Congress. Budget Authority	Pres. Request	Congress. Budget Authority
	FY1981	FY1982	FY1982
		(in $thousands)*	
A. Electric-Related Supply			
1. Magnetohydrodynamics (FE)	66,533	0	29,000
2. Geothermal (CE)	153,645	46,775	57,775
3. Hydropower (CE)	2,409	0	2,750
4. Electrical Energy Systems and Energy Storage Systems	109,800	47,525	65,625
5. Solar Power Technology (CE)	112,100	19,400	73,800
6. Magnetic Fusion (ER)	391,000	456,100	484,600
7. Uranium Resource Assessment (NE)	25,925	5,800	5,800
8. Uranium Enrichment (NE)			
a-Centrifuges (NE)**	356,315	760,300	691,800
b-Advanced Isotope Separation (NE)	79,300	85,237	85,237
9. Conventional Reactor Systems (NE)	81,500	68,000	101,750
10. Breeder Reactors (NE)			
a-Liquid Metal Fast Breeder Reactor	371,919	387,842	405,628
b-Clinch River Breeder Reactor	172,000	254,000	228,000
c-Light Water Breeder	60,200	58,000	45,000
d-Fuel Cycle R&D	47,500	26,100	48,100
11. Nuclear Waste			
a-Commercial (BE)	201,415	227,551	208,701
b-Defense (DP)	298,445	390,000	384,800
12. Mining R&D (FE)	40,169	21,000	17,000
Subtotal	2,570,175	2,853,630	2,935,366
B. Liquids and Gas-Related Supply			
13. Advanced Technology (FE)	95,761	94,500	84,500
14. Coal Liquefaction (FE)	276,997	105,200	248,200
15. Surface Coal Gasification (FE)	69,618	53,440	56,300
16. In Situ Coal Gasification (FE)	9,960	3,300	8,300
17. Enhanced Oil Recovery (FE)	16,158	20,100	20,100
18. Enhanced Gas Recovery (FE)	30,598	10,200	14,200
19. In Situ Oil Shale (FE)	32,151	16,250	22,350
20. Biomass Energy (CE)	31,650	20,500	20,500
21. Alcohol Fuels (CE)	18,000	10,000	10,000
Subtotal	580,893	338,490	484,450

* Includes deferrals and rescissions, but excludes program direction.

** Includes $293.3M in FY 81 and $695.8M in FY 82 for construction of gas centrifuge plant.

TABLE B-1 (continued)

	Congress. Budget Authority	Pres. Request	Congress. Budget Authority
	FY1981	FY1982	FY1982
		(in $thousands)*	
C. Conservation & Improved End-Use Utilization			
22. Coal Combustion Systems (FE)	37,368	38,800	42,800
23. Heat Engines & Heat Recovery (FE)	31,468	15,600	15,600
24. Fuels Cells (FE)	32,012	28,600	35,900
25. Buildings & Community Systems (CE)	52,990	28,000	47,400
26. Industrial Conservation (CE)	67,300	0	29,600
27. Transportation Conservation (CE)	102,120	37,000	59,550
28. Multi-Sector Conservation (CE)	25,800	17,500	19,600
29. Solar Applications for Buildings (CE)	224,900	84,700	118,050
30. Solar Applications for Industry (CE)	138,270	44,000	66,050
Subtotal	712,228	294,200	434,550
D. Technology Base			
31. Energy Supporting Research (ER)			
a-Basic Energy Sciences			
aa-Nuclear Sciences	33,700	37,670	37,670
ab-Materials Sciences	95,150	112,060	112,060
ac-Chemical Sciences	69,040	73,940	73,940
ad-Engineering, Math & Geosciences	25,860	32,300	32,300
ae-Advanced Energy Projects	6,650	8,220	8,220
af-Biological Energy Sciences	7,650	9,410	9,410
ag-CO_2 and Climate Research**	12,900	16,700	0
b-Technology Assessments	9,500	3,000	3,000
c-University Research	11,800	10,600	10,600
32. General Science (ER)			
a-High Energy Physics	348,180	392,700	392,700
b-Nuclear Physics	109,200	122,900	122,900
c-Nuclear Medicine	45,900	50,500	50,500
33. Environment & Safety (EP)	48,510	49,600	43,600
34. Biological & Environment Research (ER)**	155,272	153,800	176,500
Subtotal	979,312	1,073,400	1,073,400
TOTAL	4,842,600	4,559,220	4,927,766

*Includes deferrals and rescissions, but excludes program direction.

**The biological and environmental research program includes climate and CO_2 research with a total budget of $168,172 in FY1981 and $170,500 in FY1982.

TABLE B-2

TIME OF EXPECTED IMPACT

PROGRAMS	TIMEFRAME OF IMPACT*		
	Near	Mid	Long
A. Electric-Related Supply			
1. Magnetohydrodynamics (FE)		X	
2. Geothermal (CE)	X		
3. Hydropower (CE)	X		
4. Electrical Energy and Storage Systems (CE)		X	
5. Solar Power Technology (CE)		X	
6. Magnetic Fusion (ER)			X
7. Uranium Resource Assessment (NE)	X		
8. Uranium Enrichment (NE)			
a- Centrifuge (NE)	X		
b- Advanced Isotope Separation (NE)		X	
9. Conventional Reactor Systems (NE)	X		
10. Breeder Reactors (NE)			
a- Liquid Metal Fast Breeder Reactor			X
b- Clinch River Breeder Reactor		X	
c- Light Water Breeder Reactor			X
d- Fuel Cycle (R&D)			X
11. Nuclear Waste			
a- Commercial (NE)	X		
b- Defense (DP)	X		
B. Liquids and Gas-Related Supply			
12. Mining R&D (FE)		X	
13. Advanced Research Tech. Development (FE)		X	
14. Coal Liquefaction (FE)		X	
15. Surface Coal Gasification (FE)		X	
16. In Situ Coal Gasification (FE)			X
17. Enhanced Oil Recovery (FE)	X		
18. Enhanced Gas Recovery (FE)	X		
19. In Situ Oil Shale (FE)			X
20. Biomass Energy (CE)	X		
21. Alcohol Fuels (CE)	X		
C. Conservation & Improved End-Use Utilization			
22. Coal Combustion Systems (FE)		X	
23. Heat Engines & Heat Recovery (FE)		X	
24. Fuels Cells (FE)		X	
25. Buildings & Community Systems (CE)	X		
26. Industrial Conservation (CE)	X		
27. Transportation Conservation (CE)		X	
28. Multi-Sector Conservation (CE)	X		
29. Solar Applications for Buildings (CE)	X		
30. Solar Applications for Industry (CE)	X		
D. Science and Technology Base			X

APPENDIX C: DESCRIPTION OF METHODOLOGY

1. Overview Description of Methodology

The methodology used in this study can be summarized as follows. The list of RD&D programs to be prioritized was agreed upon and then each program was placed into one of four end-use areas: electric-related supply, liquids- and gas-related supply, conservation and utilization, and science and technology base programs (see Table C-1). Criteria to be used in assessing the technology priorities were selected and the definitions for each criterion agreed upon. Two sets of criteria were developed--one set of seven for the R&D programs and one set of five for the Science and Technology Base programs (see Tables C-2 and C-3).

It is important to note that the assessment or evaluation process involving the decision questionnaires which each member was asked to complete were not intended to and would not "fix" the results of the final priority ratings but were designed as an initial point of departure from which final conclusions would ultimately evolve--conclusions which may or may not be consistent with the initial ratings.

Each member of the R&D Panel was asked to make two assessments. The first was used to determine each individual's view concerning the relative importance of criteria for R&D programs and for Science and Technology Base programs. Each criterion was judged "very important" (value of 3), "reasonably important" (value of 2), or "slightly important" (value of 1) relative to Federal energy R&D priorities. A consensus weighting for reach criterion based on the average of all responses was calculated and then normalized to a value of one. The second form was the program evaluation form. For each criterion for each technology the members judged whether that criterion had a high (value of 3), medium (value of 2) or low (value of 1) importance. In addition each member was asked to state a recommended program funding level for each technology, his or her perceived level of knowledge concerning each technology, and any comments he or she wished to make concerning each technology.

The above information was then used to calculate figures of merit (FOM) for each technology. On the basis of the FOM the technologies were then ranked. The funding information was used as the basis for recommendations of future funding--namely, whether the funding for each program should be decreased, remain the same or be increased relative to the President's FY82 budget.

TABLE C-1

R,D&D PROGRAMS

Energy Related Supply Programs

- Magnetohydrodynamics (FE)
- Geothermal
- Hydropower
- Electric Energy & Storage Systems
- Solar Power Technology (CE)
- Magnetic Fusion (ER)
- Uranium Resources Assessment (NE)
- Uranium Enrichment - Centrifuge (NE)
- Uranium Enrichment - Advanced Isotope Separation (NE)
- Conventional Reactor Systems (NE)
- Liquid Metal Fast Breeder Reactor
- Clinch River Breeder Reactor
- Light Water Breeder Reactor
- Fuel Cycle R&D
- Nuclear Waste - Commercial (NE)
- Nuclear Waste - Defense (DP)

Liquids and Gas Related Supply Programs

- Mining R&D (FE)
- Advanced Technology (FE)
- Coal Liquefaction (FE)
- Surface Coal Gasification (FE)
- In Situ Coal Gasification (FE)
- Enhanced Oil Recovery (FE)
- Enhanced Gas Recovery (FE)
- In Situ Oil Shale (FE)
- Biomass Energy (CE)
- Alcohol Fuels (CE)

TABLE C-1 (continued)

Conservation and Improved End-Use Utilization Programs
- Coal Combustion Systems
- Heat Engines and Heat Recovery
- Fuel Cells (FE)
- Buildings & Community Systems
- Industrial Conservation
- Transportation Conservation
- Multi-Sectors Conservation (CE)
- Solar Applications for Buildings
- Solar Applications for Industry (CE)

Science and Technology Programs
- Energy Supporting Research (Overall)
- Basic Energy Sciences (Overall)
- Nuclear Sciences
- Materials Sciences
- Chemical Sciences
- Engineering, Math & Geosciences
- Advanced Energy Projects
- Biological Energy Sciences
- Climate and CO_2 Research
- Technology /Assessments
- University Research
- General Science (Overall)
- High Energy Physics
- Nuclear Physics
- Nuclear Medicine
- Environment and Safety
- Health & Environmental Research

TABLE C-2

EVALUATION CRITERIA FOR ENERGY R,D&D PROGRAMS

1. Technological Potential/Risk

Definition: Likelihood that the R,D&D Program will, within a reasonable period of time, result in technical success.

High (3) - Very good likelihood of technical success. (in other words, low technical risk)

Med. (2) - Reasonable chance of technical success. (in other words, moderate technical risk)

Low (1) - Only a slim chance of technical success. (in other words, high technical risk)

2. Urgency

Definition: Considering both the time period before which the technology is needed and the lead time for development, how urgent is the R,D&D program.

High (3) - Program must be started now (or continued) at a high level of effort.

Med. (2) - Program could be carried on at a moderate level now or, alternatively, delayed for 5 years or possibly 10 years.

Low (1) - There is no urgency in the program and it could be delayed for 10 years or more.

3. Economic Potential

Definition: Likelihood that the technology, when it is developed, will be economically competitive with then existing technologies providing energy in the same form or available alternative substitutable sources (note: assume development is completed no later than the year 2000).

High (3) - Economics are likely to be very competitive.

Med. (2) - Economics are uncertain or are likely to be marginally competitive.

Low (1) - Economics are likely to be non-competitive.

4. Benefit/Cost

Definition: Considering the size of the R,D&D investment needed to develop the technology, how substantial is the impact of the development of the technology in terms of end-use energy produced or saved.

High (3) - Less than $1 billion of total R,D&D investment required for each 1 Quad of energy produced or saved annually (in the year 2000).

Med. (2) - Between $1 billion and $10 billion of total R,D&D investment for each 1 Quad of energy produced or saved annually (in the year 2000).

Low (1) - More than $10 billion of total R,D&D investment for each 1 Quad of energy produced or saved annually (in the year 2000).

5. Energy/National Security

Definition: How significant is the energy technology from the standpoint of displacing or substituting for insecure foreign energy sources (primarily oil).

High (3) - Will displace or substitute for 2.0 million barrels/day or more (about 4 quads/yr) or oil equivalent by the year 2000.

Med. (2) - Will displace or substitute for 0.5 to 1.99 million barrels/days of oil equivalent by 2000.

Low (1) - Will displace or substitute for less than 0.5 million barrels/day of oil equivalent by 2000.

6. Safety, Security, Health and Environmental Impact

Definition: Both from the standpoint of the general public and the worker, the degree to which the technology is safe, secure, healthy and has minimal (or even positive) environmental impacts.

High (3)	technology results in improved safety, health and environmental impact.
Med. (2)	technology would have some adverse safety, health or environmental consequences, but not serious ones considering potential control measures.
Low (1)	technology has serious safety, security, health or environmental problems.

7. Federal RD&D Role

Definition: considering the RD&D support for the technology that is likely to come from industry, how important to timely commercialization is Federal RD&D support.

High (3)	- heavy Federal support is essential since because of the risk or long development period, industry support will be small.
Med. (2)	- some Federal support is needed to complement industry efforts or to ensure timely development.
Low (1)	- little or no Federal support is needed since industry efforts are likely to be adequate.

ADDITIONAL EVALUATION CRITERIA FOR SCIENCE AND TECHNOLOGY BASE PROGRAMS

Most of the above criteria are not directly applicable to evaluating DOE Technology Base programs. The benefits of these basic and applied research and engineering development activities must be measured against different criteria for obvious reasons. The following criteria are to be used for evaluation of the science and technology programs listed in Attachment 4D:

8. Scientific Potential

Definition: degree to which the research program will advance scientific knowledge or contribute toward maintenance of American scientific leadership and achievements in a respective field and, therefore, represents an important national trust.

High (3) - Very likely to produce significant advances in scientific knowledge on important new frontiers of science.

Med. (2) - likely to add substantially to fundamental knowledge in relatively developed and mature fields.

Low (1) - not likely to add substantially to new knowledge.

9. Inventive Potential (Risk/Benefit)

Definition: likelihood that the R&D program will over the long term directly produce breakthroughs, discoveries, or inventions in energy production, usage, or conservation which have significant economic, social or environmental benefits and, thereby, justify the risks/costs of the applied science and engineering research efforts.

High (3) - very likely that the R&D program will directly result in energy developments with significant economic, social, or environmental benefits over the long-run.

Med. (2) - likely that the program will at least break even in producing energy developments with economic, social, and environmental benefits over the long-run.

Low (1) - not likely to produce energy developments with direct economic, social, or environmental benefits.

10. Mission Impact

Definition: degree to which the R&D program supports or underwrites the success of DOE technology development programs by providing the technology base for understanding fundamental working properties of the technology, solving known and unanticipated engineering development problems, and transferring new engineering knowledge to other energy applications and missions.

High (3) - program provides essential research and engineering support for critical energy technology development missions and goals.

Med. (2) - program provides general support with widespread applications to technology development missions or areas with less critical problems or secondary missions.

Low (1) - program does not directly support technology development programs, but may have general applications.

The following two RD&D program criteria are applicable to the science and technology base programs and are to also be used in evaluating the science and technology base programs.

2. Urgency

Definition: same as RD&D criterion Number 2 above

7. Federal Role

Definition: same as RD&D criterion Number 7 above

APPENDIX D

ENERGY RESEARCH ADVISORY BOARD DISSENT TO RECOMMENDATIONS WITH RESPECT TO CLINCH RIVER BREEDER REACTOR

EXECUTIVE SUMMARY

Cancellation of the Clinch River Breeder Reactor Project at this time would not only result in time loss of investment of over $1 billion already incurred to date, but would also dissipate the hard-won technology capability already developed in the U.S., probably for the remainder of the century. Even if one accepts the argument that the breeder reactor program would only provide a useful option for energy generation sometime in the future, it is still necessary to complete the Clinch River Project in order to actually demonstrate this technology in the U.S. licensing and safety environment. Proven technology does not exist without an actual demonstration of acceptable safety, reliability, and operability. Although it is obvious from the achievements of the French, Japanese, British and Russian programs that sodium-cooled fast breeder reactors are practical, it has not been demonstrated that such plants can be designed, built and operated by U.S. technology and industry within the constraints imposed by domestic safety and licensing standards. The consideration of technology demonstration and preservation of U.S. presence in the worldwide breeder development program requires that the CRBR project be rapidly completed.

BASIS OF DISSENT

The energy future of the U.S. is subject to so many variables that no one can adequately predict what course the future will take with respect to energy. We do not know with any certainty how much energy will be used in 2000, for example, or what effect this will have on the growth of our economy.

It is also far from clear what quantities of the various fuels will be available. The U.S. must be prepared to cope with such undesirable events as partial or total cut-off of imported oil.

Electricity is a uniquely flexible form of energy. The transmission and distribution systems can be used to accommodate any source of generation, thus utilizing the energy source available at the time. The electricity can be transmitted to almost any desired point of use. This would be particularly useful in the event of disruption of energy sources due to any cause including enemy action.

The most available sources of energy, coal and uranium, can be best used to produce electricity. A larger part of U.S. energy needs could be supplied by electricity. It could be used for almost all space heating and provide much of the process energy required. This could be done in a more energy efficient and environmentally satisfactory way by the use of heat pumps.

It is predicted by the DOE that from 36 to 50 percent of the primary energy in 2000 will be used for the generation of electricity. It is probably possible to accomplish this, almost entirely by burning coal, but it almost certainly would not be the optimum choice on either economic or environmental grounds. There are clearly some undesirable health effects from burning coal and these should be minimized.

If one assumes that the upper end of the DOE 2000 LWR capacity projection of 200 GW occurs, this would require committing about 50 GW between now and 1990. Most, if not all of these reactors would be committed between 1985 and 1990. If there is about 900 GW of generating capacity in 2000 and the growth rate is 3.5 percent per year, then 31.5 GW plus replacements will be committed per year by 1990. It would seem reasonable for the nation to be in a position to have as much as 20 GW per year by nuclear plants. While it is possible that many of these plants could be coal burning, there are enough potential problems with coal plus the possible economic advantages of nuclear, that we should be able to take advantage of that option. This might amount to 243 GW of nuclear plants being committed between 1990 and 2000.

A 3.5 percent growth rate after 2000 would required additional capacity of about 540 GW, plus replacements, to be committed for operation by 2020. If half of this is LWR's then by 2010 about 4.6 million tons of uranium would have been committed for a 30 year life. If the life is 40 years, then 4.9 million tons would have been committed by 2010. (With a 40 year life there would be fewer replacements by 2020.)

According to a recent DOE report, there is a 95 percent confidence that there is 3,875,000 tons of U_3O_8 in the U.S., at a forward cost of $100 per pound. This includes reserves as well as probable, possible and speculative reserves.

Forward costs are operating and capital costs in 1980 dollars that would be incurred in producing the uranium; they exclude income taxes, profits, cost of money and sunk costs. The market price that would support a 15 percent rate of return has been estimated to be 1.4 - 1.6 times the forward cost per pound of U_3O_8.

It should be remembered that if there is the demand for uranium that approaches the amount potentially available the price rises accordingly.

The U.S. also has to a considerable degree a contractual, political and moral obligation to supply a considerable amount of uranium to industrial and developing nations.

The breeder should start being deployed in a significant way by 2010 or before as it is by no means assured that we would otherwise have the uranium required.

If reactors can be built in the time that is technically possible and if fewer design changes are made during construction, costs can be drastically reduced. This would make them the clear choice from the point of view of economics. To be able to take advantage of this may require deployment of breeders by 2010.

Even if breeders are not required due to the lack of uranium for LWR's, it may well be desirable to deploy them on economic grounds. The economics of the LMFBR compared to the LWR using break-even analysis has been extensively examined by various U.S. groups. The majority conclusion is that the break-even could occur around the year 2000 at an equivalent 30 year levelized price of uranium of about $50 - $150 per pound, in 1980 dollars.

The capital cost of breeders is higher than that for LWR's but the fuel cost is lower. This provides a good hedge against inflation as the capital costs will be a larger fraction of the kilowatt-hous cost and will remain constant. The longer the lifetime used in the evaluation, the more favorable for the breeder.

Recent cost benefit studies, using econometric models, have shown that benefits measured in hundreds of billions of dollars would accrue from early as opposed to late introduction of the LMFBR.

There has been no even marginally commercially successful reactor without a previous demonstration plant having been built. Those involved with the reactor development program believe that a demonstration plant is essential. There will be many things that will not work as well as would be desired when they are put together in a complete reactor system. The information learned from such a demonstration will lead to far better second and subsequent generation plants.

No U.S. reactor has even been built with a single scale up as large as would be represented by the scale up from FFTF to a 1000 MW reactor.

The major reason for success in both the Naval nuclear and the LWR program was that in each case there was a reactor being built which provided a focus for the research effort.

The refocusing of a broad range R&D program, even one already focused on the needs to build a plant, will be greatly improved as the result of data obtained in the design, construction and operation of a demonstration plant.

One of the principal reasons for the success on the LWR's has been the infrastructure, suppliers of equipment and services, that had been created and nurtured. Cancellation of the CRBR will cause a break in the industry continuity and many suppliers may be reluctant to get back into the breeder business.

If CRBR is not continued, then it will have to be replaced by another demonstration plant. The size could be somewhat but not much larger. This would require many additional years and far more money. If CRBR is completed the next plant can be built for considerably less than it would otherwise cost.

To date, there has been $1.148 billion spent on CRBR, $246 million of components have been delivered and $352 million more are on order. There are 3200 people working on this project and design is 86 percent completed.

The design of CRBR is as advanced as any in the world. The design techniques and safety studies are more advanced than those in any other country. The CRBR can accommodate changes required to demonstrate the LMFBR system, including alternate fuel systems.

In fact, the recently completed conceptual design study (CDS) by the DOE which assumes construction and operation of CRBR, contains relatively modest changes to the basic CRBR design. For example, the 1000 MW CDS plant would have the same core and IHX design concepts, and its containment would be based on the same design philosophy as CRBR.

Although the fuel handling systems of each plant are quite different, other CDS reactor components only reflect modest extension of CRBR design experience, such as reactor vessel piping with internal downcomers; shutdown heat removal system within the reactor vessel; four loops vs three; two stage coolant pump which retains the hotleg feature of CRBR; and flexibility to accommodate any one of three steam generator designs.

The CRBRP will serve as an important step in beginning the transition of the fast breeder reactor program from the technology development stage to the decision point of large-scale commercial utilization. The major objectives of the project are: 1) to demonstrate the technical performance, reliability, maintainability, safety, environmental acceptability and economic feasibility of the LMFBR central station electric power plant in a utility environment, and 2) to confirm the value of this concept for conserving important non-renewable natural resources.

Although paper studies, laboratory experiments, and component testing are essential steps in developing complex new technology, only the practical demonstration of the fully integrated systems can move it nearer to readiness for commercial use. The history of light water reactor development suggests that CRBR would be the first of probably two demonstration plants built in tandem before there can be sufficient investor confidence to make commercial deployment possible. Such tandem demonstrations will require about 25 years for design, licensing, construction, testing and demonstration of operating reliability and maintenance requirements. This would bring us to about the year 2007 before our nation is postured to commit additional breeders that would then begin to make their first energy contribution in about 2020. If Clinch River should be terminated, the entire program will stretch out at least an additional ten years.

With the risks of oil supply, the uncertainties of the environmental acceptability of massive additional use of coal, and the unknown about future uranium for LWR's, our nation can ill afford the risk of arriving at 2007 and not have the capability to deploy the breeder. It may not be needed until later, but if it should be needed then and not available, the consequences could be severe. Breeders will multiply the energy recoverable from our nation's uranium reserves by a hundredfold or more.

In dissenting from the majority vote of ERAB, the undersigned also feel that Clinch River suffered from the criteria used in voting and weighing procedures. Clinch River cannot possibly save energy by 2000, it will not replace oil by then, it has no economic potential during this century, all of which cause CRBR to receive low ratings in these categories. We do feel that it is an essential and integral part of the on-going LMFBR program which received high ratings, and CRBR should proceed with dispatch.

Respectfully submitted: John W. Simpson
Roland W. Schmitt
William S. Lee
Louis H. Roddis

ENERGY RESEARCH ADVISORY BOARD
ADDITIONAL REMARKS BY THOMAS B. COCHRAN
WITH REGARD TO THE CLINCH RIVER BREEDER REACTOR

In its initial evaluation of DOE energy R&D programs, at least two-thirds of the members of the ERAB agreed that the Clinch River Breeder Reactor (CRBR) has low urgency, low economic potential, low benefit-to-cost ratio and that funding should be reduced. In the final analysis three-quarters of the ERAB members recommended that the "[breeder reactor] demonstration be delayed until a future time" -- a statement which clearly implies termination of the present CRBR project.

Four ERAB members have attached a six page dissent to the five sentences devoted to the CRBR*/ in this 46 page report, which evaluates 49 program areas covering all DOE energy R&D. Under normal circumstances, the report of the majority should respond to the points raised by the minority. Because ERAB was under an extremely tight schedule to complete this exercise, no time was made available to provide for a majority discussion of the minority view. Consequently, the following comments by one member of the majority are presented in order to provide some balance to the discussion of the CRBR issue.

URANIUM SUPPLY

In order to counter the majority view that "sufficient... uranium supplies exist to satisfy projected levels of electric demand for at least 40 years and possibly well beyond" (p. 43), the minority states that "no one can adequately predict what course the future will take with respect to energy" and then proceeds to present its own high nuclear growth scenario.**/ This has the effect of exhausting low cost uranium resources sooner than otherwise projected, thus making an earlier commitment to a breeder demonstration plant more persuasive.

The simple response to this argument is that when one is not ordering any new reactors, one is not going to run out of uranium. This, the current reality, is consistent with the low nuclear growth scenario of the most recent energy projection of the DOE Energy Information Agency's (EIA). It assumes no nuclear plants will be constructed beyond those where construction is already 10 percent complete. While this will probably be the most accurate of the EIA projections,[*] the following table shows that the minority estimate of nuclear plants built by 2020 (committed by 2010) is almost 2.5 times the EIA intermediate growth scenario and more than twice the nuclear capacity in EIA's highest nuclear scenario.

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*/ Three of these five sentences (at pages 2, 19, and 43) summarize statements in the other two.

**/ If this approach were applied to all energy R&D activities it would make orderly program planning and this ERAB exercise meaningless.

YEAR	DOE-EIA INTERMEDIATE-CASE GWE	HIGH-CASE GWE	ERAB MINORITY GWE
1981	60	60	60
2000	175	195	200
2020	290	350	713

With its very high nuclear growth after 1990, the minority then argues that we will have committed 4.6 million tons of uranium by 2010 -- exceeding the domestic resources at a forward cost of $100/lb. The minority has conveniently ignored a) any reduction in LWR uranium requirements through increased fuel-use efficiency and reduced enrichments tails with advanced technology (30% to 50% improvements have been projected)[**] b) any improvements in uranium mining technology over the next 30 to 60 years; c) the more robust world uranium resource pictures;[***] and d) the availability of higher cost (lower grade) resources, domestic and foreign.

To further exacerbate the uranium supply picture, the minority implies that utilities will not build a nuclear plant in 2010 unless the uranium for all plants operating in 2020 is assured through 2050. This conveniently ignores the world experience with breeders that will be

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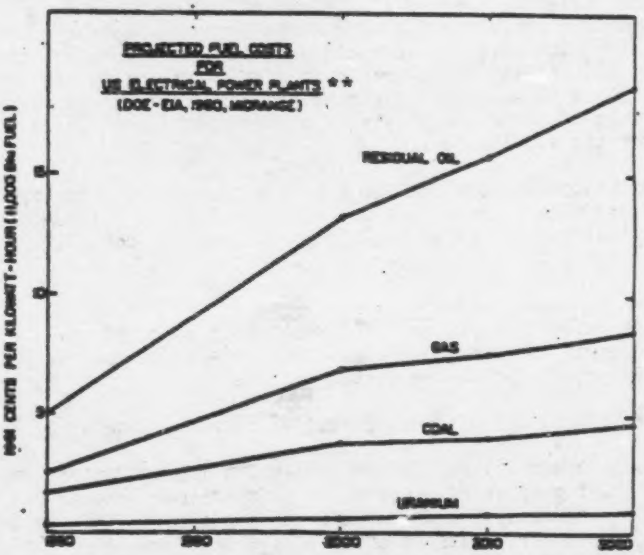
[*] It should be noted that DOE and its predecessor agencies have consistently overestimated total energy, total electric, and nuclear electric energy growth during the past eight years.

[**] DOE, NASAP Report, DOE/NE-0001, Executive Summary, June 1980, p. 11.

[***] Two of our closest allies, Canada and Australia, are major export countries. In part because of competition from cheaper, higher grade foreign uranium resources, the domestic uranium producers are currently seeking protective import restrictions.

CONCLUDING REMARKS

The ERAB report raises the question of whether "federally-sponsored nuclear programs are receiving a larger portion of funding completely out of line with the expected nuclear share of the US energy mix during the next few decades." In the President's FY 1982 energy R&D budget $875.6 million -- some 31% of all R&D funds exclusive of the Science and Technology Base (see Table III-D) -- is devoted to breeders and advanced uranium enrichment technologies.*/ These activities can be seen, as viewed from the market place, as attempts to reduce the impact of rising uranium prices. The figure below on the next page suggests that the problem is not with the uranium but with oil. When one also realizes that a) we can safely defer a commitment to the CRBR, b) the LMFBR base program expenditures can be substantially reduced once the program is refocussed for the longer term, c) a 50% reduction in the price of uranium enrichment will reduce electricity prices by only 0.1¢/kwh, d) our national security problem is with oil, not uranium, and e) improvements in energy productivity have proven to be the more cost effective means of providing additional "supplies," there can be little doubt that DOE energy R&D priorities are misplaced.



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*/ $875.6 million represents the sum of the budgets for the LMFBR Base, CRBR, Breeder Fuel Cycle R&D, Uranium Enrichment R&D (Centrifuge and AIS), and the LWBR (See Table IV-A, pp.20).

**/Frank von Hippel, Testimony before the Subcommittee on Energy Conservation and Power, of the House Committee on Energy and Commerce, October 5, 1981.

the range of $3.2 billion (1981 dollars) making the forward cost in excess of $2 billion,*/ an amount well worth saving, or applying to other more cost effective energy R&D programs. Furthermore, the $2 billion forward cost estimate is unrealistically low.**/

DEMONSTRATION OF SAFETY AND LICENSING

The minority claims that "even if one accepts the argument that the breeder reactor would only provide a useful option in the future it is still necessary to complete the Clinch River Project in order to actually demonstrate *this* technology in the US licensing and safety environment."***/ Safety and licensing requirements, however, are evolving and would likely change drastically by the time the breeder is commercialized.****/ There is little to be gained by demonstrating *present* breeder technology in the *current* licensing and safety environment. Even if one accepted the minority view that one might wish to deploy breeders in 2010, it would make far more sense to demonstrate licensing in 2000, some 20 years hence.

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*/ The latest total CRBR project cost estimate is $2.88 billion (1980 dollars), based on 8% escalation rate and a completion date of 1988. By way of comparison the entire project was estimated in 1973 to cost $700 million.

**/ It is based on a) the unlikely prospect that DOE will obtain approval from NRC to begin site work prior to completion of safety and environmental reviews, b) estimates of the construction schedule and cost that do not reflect the experience of most nuclear projects of this type, and c) the assumption that the Clinch River site is suitable. With regard to the last, NRC may require an alternate site, in part because of unfavorable meteorology and post TMI limits on population density. In this event the project would be set back an additional 4 years at an added cost of $1.7 billion.

***/ This argument would have been a bit more persuasive were it not for the fact that DOE has just requested a licensing exemption for the NRC (Letter from DOE Secretary Edwards to Nunzio Pallidino, Chairman NRC, Nov. 30, 1981) in order to commence early site preparation work prior to completion of the required safety and environmental reviews and hearings. This request, if granted, would enable DOE to initiate site work prior to the next CRBR budget review by the Congress.

****/ Anyone who seriously questions this need only examine the effect the TMI accident has had on the licensing requirements in effect just two years ago.

DISSENT TO THE RECOMMENDATION WITH RESPECT TO ELECTRIC AND HYBRID VEHICLES

Electric and hybrid vehicle technology is high risk, but promising, and its continued development would well serve the long term national interest. The technology is high risk because the economic viability of electric and hybrid vehicles has not been demonstrated. It is promising because of the rapid advances in the offing for performance improvements and cost reductions of electric drive systems based on power semiconductor devices, and because of continued progress in battery technology. And, it would serve the long term national interest because it directly addresses the problem of total dependence of the US on liquid fuels for personal transportation services.

Under normal circumstances it would be expected that development of electric vehicle technology would be pursued at a reasonable level by the automobile industry. However the present condition of the industry is such that it cannot be expected to pursue this high risk development without some Federal support. Termination or sharp reduction of the Federal program at the present time would significantly delay electric vehicle development and substantially increase the risk that this technical option would not be ready at the time when it might be needed.

Respectfully submitted: Roland W. Schmitt

Mrs. **Bouquard**. We will continue our fiscal year 1984 DOE authorization hearings tomorrow. We will hear from the Department of Energy on nuclear waste management. That hearing is scheduled to begin in this room in the morning at 9:30.

I want to thank all of you for being here.

The committee is adjourned.

[Whereupon, at 12:02 p.m., the subcommittee recessed, to reconvene the following day, February 24, 1983, at 9:30 a.m.]

APPENDIX

1. Is the DOE goal to terminate federally-supported R&D subsequent to the completion of the Large-Scale Prototype Breeder plant realistic?

The high technology nature of the breeder fuel cycle demands that government activity continue beyond the completion of the large-scale prototype breeder reactor to continually advance the basic breeder technology and to assure that the fuel cycle steps are developed in a safe and secure manner. The fuel cycle activities should include research and development on fuel design optimization, fuel fabrication, fuel reprocessing and recycling technology. The efforts should continue until the early commercial reactors have operated long enough to achieve substantial fuel cycle experience.

2. What impact, if any, does the breeder development program have on aiding the recovery of the nuclear industry to a healthy status?

The breeder development program has little impact on the nuclear industry in terms of direct beneficial effects on the problems which confront light water reactors (LWRs) today. A viable breeder program, however, provides current peripheral benefits to the industry because of the central role that breeders must play if nuclear fission is to be a long-term source of electricity. Moreover, because today's convertor reactor industry is limited to a few more decades by limited uranium resources, breeder development provides motivation to continue today's LWRs in anticipation of the greater benefits of breeder reactors over the long-term in providing a viable nuclear industry. Maintaining confidence in the breeder program carries over to today's industry in terms of political and public support for continuing the nuclear option.

3. Do you believe that the Administration's proposed FY 1984 Breeder Reactor program is adequate? Please identify any areas of concern to you.

Our views regarding the adequacy of the Administration's proposed FY 1984 Breeder Reactor program are:

a) With respect to the LMFBR base program, funding is adequate to continue the R&D foundation necessary to complement the Clinch River demonstration and large-scale prototype breeder reactor.

b) With respect to the large-scale prototype breeder reactor, funding is adequate to continue the Department's efforts with private industry and foreign governments to establish research and development needs, a conceptual design, cost estimate, financing and institutional arrangements and a schedule that reflects the requirements of electric utilities and foreign governments.

c) With respect to the Clinch River Breeder Reactor Project (CRBRP), the $270 million budget request is inadequate. A $370 million appropriation, combined with previously committed private funds, is needed to attain the $467.9 million cited by the Department as necessary to keep CRBRP on schedule through Fiscal Year 1984.

4. Please discuss in general terms some ways to make the next breeder plant (beyond CRBR) commercially attractive (e.g., standardization in design).

The next breeder plant can be made more attractive commercially by:

a) Providing for a coordinated effort among the government, utilities and manufacturers in the development of a standardized design and to do so with international cooperation and participation.

b) Putting in place a licensing process that will allow early site approval and provide overall stability so crucial to enhancing the confidence of utilities who are looking for a predictable, workable system under which to build and operate breeder plants.

POOL OR ~~VS~~ LOOP

In liquid metal fast breeder reactor design, the question of pool or loop is basically one of packaging the primary system. With pool technology, the entire primary system is packaged within a single tank, whereas loop technology uses a combination of a tank and building cells. Beyond that, the technologies are very similar, with most reactor systems the same or only slightly different.

POOL/LOOP SYSTEM COMPARISON

	SAME	DIFFERENT ONLY IN CAPACITY, SIZE, FLOW, ETC.	SIGNIFICANTLY DIFFERENT
NUCLEAR ISLAND ELECTRICAL POWER	X		
EMERGENCY DIESEL GENERATOR	X		
REACTOR SERVICE BUILDING	X		
STEAM GENERATOR BUILDING	X		
DIESEL GENERATOR BUILDING	X		
CONTROL BUILDING	X		
REACTOR CONTAINMENT			X
CHILLED WATER		X	
RADIATION WASTE	X		
HEATING, VENTILATION & AIR CONDITIONING		X	
SODIUM FIRE PROTECTION		X	
RECIRCULATION GAS COOLING		X	
REACTOR CORE & BLANKET	X		
REACTOR INTERNALS			X
REACTOR ENCLOSURE			X
REACTOR & VESSEL INSTRUMENTATION	X		
PRIMARY HEAT TRANSPORT SYSTEM			X
INTERMEDIATE HEAT TRANSPORT SYSTEM	X		
DECAY HEAT REMOVAL SYSTEM	X		
STEAM GENERATOR SYSTEM	X		
HEAT TRANSPORT INST. & CONTROL			X
AUXILIARY LIQUID METAL	X		
INERT GAS RECEIVING & PROCESSING		X	
IMPURITY MONITORING & ANALYSIS	X		
REACTOR REFUELING	X		
MAINTENANCE EQUIPMENT	X		
LEAK DETECTION SYSTEM		X	
TRACE HEATING		X	
PLANT CONTROL	X		
DATA HANDLING & DISPLAY	X		
FUEL FAILURE MONITORING	X		
FLUX MONITORING	X		
RADIATION MONITORING	X		
PLANT PROTECTION	X		

8145-1

CLINCH RIVER: THE MOST TECHNOLOGICALLY ADVANCED BREEDER DESIGN IN THE WORLD

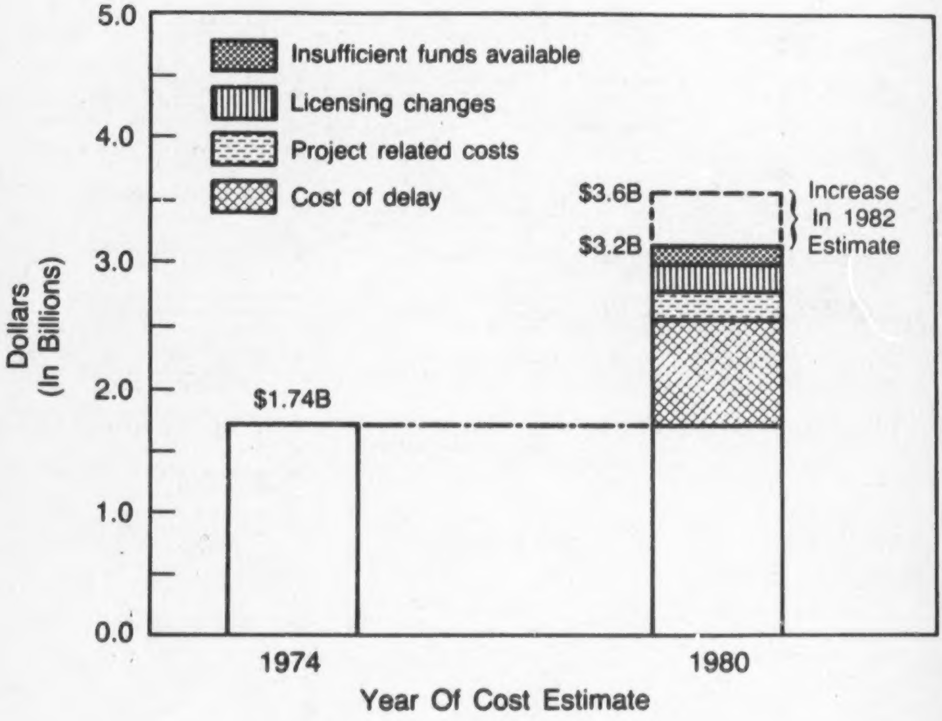
DESIGN FEATURE	U.S. CLINCH RIVER	JAPAN MONJU	FRANCE SUPERPHENIX	U.K. CDFR-1	W. GERMANY SNR-300	USSR BN-800
POOL DESIGN			X	X		X
LOOP DESIGN	X	X			X	
HETEROGENEOUS CORE	X					
HUMAN FACTORS CONTROL ROOM	X	X		X		
CONTAINMENT/CONFINEMENT WITH FILTERED VENTING	X	X	X		X	
ALL REACTOR BUILDINGS ON A COMMON MAT	X	X		X	X	
INDEPENDENT, REDUNDANT AND DIVERSE SHUTDOWN SYSTEMS	X	X	X	X	X	X
SHORT SHAFT COOLANT PUMP	X					
HOT LEG PRIMARY COOLANT PUMP	X				X	
WIRE REPLACER MULTIPLEXING	X					
INDEPENDENT DECAY HEAT REMOVAL SYSTEM	X	X	X	X	X	X
HCDA QUALIFIED REACTOR HEAD	X	X	X	X	X	X
NATURAL CIRCULATION CAPABILITY	X	X	X	X	X	X
TURBINE DRIVEN AUXILIARY FEEDWATER	X	X	X	X	X	X
STEAM GENERATOR QUALIFIED TUBE GUILLOTINE RUPTURE	X	X	X	X	X	X
SODIUM/WATER REACTION ACCOMMODATION OF INTERMED. PIPING	X	X	X	X	X	X
VALVELESS INTERMEDIATE LOOP	X					X
PRIMARY AND SECONDARY SYSTEM CELL LINERS	X	X	N/A	N/A	X	N/A
BENT-TUBE STEAM GENERATOR	X			X		
ON-LINE ACCESSIBILITY OF HEAD ACCESS AREA	X	X	X	X	X	X
SUPERHEATED STEAM CYCLE	X	X	X	X	X	X
INCONEL CLAD UPPER INTERNALS	X	NOT DECIDED YET	N/A	N/A		N/A
SODIUM/WATER REACTION SENSOR AT STEAM GENERATOR OUTLETS	X	X	X	X	X	X
STRAIGHT-PULL REFUELING MACHINE	X	X	X	X	X	X
LIMITED FREE BOW CORE RESTRAINT	X					

CLINCH RIVER DESIGN FEATURES

FEATURE	FUNCTION	BENEFIT
LOOP DESIGN	PROVIDES REACTOR COOLING VIA PRIMARY AND INTERMEDIATE SODIUM-FILLED COOLING LOOPS	● LICENSABLE PER U.S. REGULATIONS ● ZERO REACTIVITY IN INTERMEDIATE LOOP ● EASE OF MAINTENANCE
HETEROGENEOUS CORE	DISPERSES BLANKET ASSEMBLIES WITHIN CORE REGION TO ENHANCE CORE PHYSICS PERFORMANCE	● INCREASES PLUTONIUM BREEDING RATIO ● IMPROVES CORE SAFETY CHARACTERISTICS
HUMAN FACTORS CONTROL ROOM	PROVIDES REACTOR PLANT CONTROL	● ENCHANCES COMMUNICATION BETWEEN PLANT SYSTEM AND OPERATOR THROUGH INSTRUMENTATION AND CONTROL SCHEMES RESULTING FROM LESSONS LEARNED FROM TMI
CONTAINMENT/ CONFINEMENT	PROVIDES MULTIPLE BARRIERS BETWEEN THE REACTOR SYSTEM AND THE ENVIRONMENT	● PROVIDES AN ADDITIONAL SAFEGUARD IN THE UNLIKELY EVENT OF AN ACCIDENT
ALL REACTOR BUILDINGS ON A COMMON MAT	RESULTS IN COMMON FOUNDATION FOR ALL BUILDINGS	● IMPROVES PLANT RESPONSE TO EARTHQUAKES
INDEPENDENT, REDUNDANT AND DIVERSE SHUTDOWN SYSTEMS	PROVIDES MEANS OF SHUTTING DOWN THE REACTOR DURING NORMAL AND OFF-NORMAL OPERATION	● RESULTS IN THE AVAILABILITY OF TWO COMPLETELY UNIQUE AND HIGHLY RELIABLE SYSTEMS THEREBY ENHANCING REACTOR SAFETY
SHORT SHAFT COOLANT PUMP	PUMPS SODIUM THROUGH PRIMARY AND INTERMEDIATE REACTOR COOLANT LOOPS	● IMPROVED RESISTANCE TO EARTHQUAKES ● EASIER SCALEUP TO LARGER SIZES
HOT LEG PRIMARY COOLANT PUMP	PUMPS SODIUM THROUGH PRIMARY REACTOR COOLANT LOOPS	● ALLOWS ATMOSPHERIC PRESSURE COVER GAS IN REACTOR VESSEL
WIRE REPLACING MULTIPLEXING	PROVIDES EFFICIENT ELECTRONIC CONTROL PATH BETWEEN CONTROL ROOM AND REACTOR PLANT SYSTEMS	● REDUCES CABLING REQUIREMENTS THEREBY IMPROVING RELIABILITY
INDEPENDENT DECAY HEAT REMOVAL SYSTEM	REMOVE VIA INDEPENDENT SYSTEM THE HEAT GENERATED BY RADIOACTIVE DECAY OF FUEL AND FISSION PRODUCTS FOLLOWING REACTOR SHUTDOWN	● PROVIDES A DIVERSE SYSTEM FOR THE REMOVAL OF RADIOACTIVE DECAY HEAT THEREBY INCREASING RELIABILITY AND ENHANCING SAFETY
HYPOTHETICAL CORE DISRUPTIVE ACCIDENT (HCDA) QUALIFIED REACTOR HEAD	PROVIDES CLOSURE FOR THE TOP OF THE REACTOR VESSEL WHILE PROVIDING PENETRATIONS FOR CONTROL MECHANISMS AND REFUELING EQUIPMENT	● PROVIDES CONTAINMENT IN THE UNLIKELY EVENT OF AN HCDA
NATURAL CIRCULATION CAPABILITY	PROVIDES REACTOR COOLING VIA NON-PUMPED NATURAL HEAT REMOVAL PROCESSES	● COOLS REACTOR EVEN WITH THE ABSENCE OF PRIMARY AND INTERMEDIATE COOLANT PUMPS
TURBINE DRIVEN AUXILIARY FEEDWATER PUMPS	PROVIDES POWER TO STEAM GENERATOR FEEDWATER PUMPS	● SYSTEM USES PLANT GENERATED POWER IN THE EVENT OF A LOSS OF OFFSIGHT ELECTRIC POWER

FEATURE	FUNCTION	BENEFIT
STEAM GENERATOR QUALIFIED FOR 3 TUBE GUILLOTINE RUPTURES	MEETS U.S. DESIGN STANDARDS FOR LMFBR STEAM GENERATORS	● SAFELY ACCOMMODATES HIGHLY UNLIKELY DOUBLE ENDED STEAM GENERATOR TUBE BREAKS WHICH RESULT IN A SODIUM/WATER REACTION
SODIUM/WATER REACTION ACCOMMODATION OF INTERMEDIATE PIPING	PROVIDES QUALIFIED PIPING FOR INTERMEDIATE SODIUM-FILLED REACTOR COOLANT LOOPS	● SAFELY ACCOMMODATES LEAKING OF WATER INTO INTERMEDIATE SODIUM-FILLED COOLANT LOOPS
VALVELESS INTERMEDIATE LOOPS	REMOVES HEAT, VIA SODIUM-FILLED COOLANT LOOPS, FROM THE REACTOR'S SODIUM-FILLED PRIMARY COOLANT LOOPS; ALSO PROVIDES A NON-RADIOACTIVE BARRIER BETWEEN THE RADIOACTIVE PRIMARY LOOPS AND THE STEAM-PRODUCING WATER LOOPS	● RESULTS IN HIGH DEGREE OF PLANT RELIABILITY DUE TO ABSENCE OF MECHANICAL VALVES
PRIMARY SYSTEM CELL LINERS; INTERMEDIATE SYSTEM CATCH PANS	ACCOMMODATES ACCIDENTAL RELEASE OF SODIUM FROM COOLANT LOOPS	● INCREASED SAFETY DUE TO ENHANCED SODIUM FIRE CONTROL
BENT TUBE STEAM GENERATOR	TRANSFERS HEAT FROM INTERMEDIATE SODIUM-FILLED COOLANT LOOPS TO WATER LOOPS THEREBY PRODUCING STEAM FOR THE PLANT TURBINE	● UNIQUE DESIGN ALLOWS UNRESTRAINED MOVEMENT OF STEAM GENERATOR TUBES DUE TO SYSTEM TEMPERATURE VARIATIONS ● ENHANCES SAFETY RELIABILITY, AND AVAILABILITY
ON-LINE ACCESSIBLE HEAD ACCESS AREA	PROVIDES ACCESSIBILITY TO REACTOR HEAD AREA FOR INSPECTION AND MAINTENANCE WHILE REACTOR IS OPERATING	● ENHANCES PLANT AVAILABILITY
SUPERHEATED STEAM CYCLE	PROVIDES SUPERHEATED STEAM TO PLANT TURBINE	● RESULTS IN HIGHER PLANT THERMAL EFFICIENCY
INCONEL-CLAD UPPER INTERNALS	PROTECTS THE REACTOR VESSEL'S STAINLESS STEEL UPPER INTERNALS FROM THERMAL CYCLING DAMAGE	● IMPROVES UPPER INTERNALS COMPONENT LIFETIME
SODIUM/WATER REACTION SENSORS AT STEAM GENERATOR OUTLETS	SENSES SODIUM/WATER REACTION IN STEAM GENERATOR, INITIATING PLANT SHUTDOWN	● IMPROVES PLANT SAFETY AND PROTECTS STEAM GENERATOR FROM EXTENSIVE DAMAGE
STRAIGHT-PULL REFUELING MACHINE	PROVIDES A PRECISE AND RELIABLE MEANS OF REACTOR REFUELING VIA A VERTICAL MACHINE PERPENDICULAR TO THE TOP OF THE REACTOR CORE	● SHORTENS REFUELING TIME THEREBY INCREASING PLANT AVAILABILTY ● ENHANCES REFUELING MACHINE RELIABILITY
LIMITED FREE BOW CORE RESTRAINT	MECHANICALLY RESTRAINS FUEL AND BLANKET ASSEMBLIES DURING NORMAL AND OFF-NORMAL OPERATION	● EFFECTIVELY MAINTAINS CORE GEOMETRY TO INSURE CORE PERFORMANCE, LIFETIME AND SAFETY

MAJOR COST ESCALATIONS HAVE BEEN DUE TO FACTORS OUTSIDE PROJECT CONTROL



Generating Capacity in U.S. Electric Utilities:

How Is It Used?
How Much Is Needed Over the Decade?

EA-2639-SR
October 1982

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Perspective

Every industry providing a product or service must allow for the repair and maintenance of equipment and the unavailability of productive resources. The more essential that product or service, the greater the need for a margin of safety to insure a secure supply. Although electricity is essential to the health, safety and economic well-being of this nation, the need for a generating capacity margin in the U.S. utility industry is not well understood.

This study was commissioned to address a misconception by national policy makers that current generating capacity, because it is about one-third greater than current demand, provides for many years of economic growth without building new generating capacity. This study is not intended to examine the plans and objectives of individual utility systems, but to provide a general basis for communicating how generating capacity is used and how much is needed to support national economic growth.

One source of misunderstanding may be the traditional use by the industry of the term "reserve margin." Reserve implies something held back or set aside for future use. As the report illustrates, however, most of the current generating capacity margin in the U.S. utility industry is not held back or set aside, but is needed to meet the demands of today's users of electricity. The report shows, in fact, that, over the past four years, 92 percent of the nation's generating capacity was needed to provide reliable service to current electricity users. The remaining 8 percent provides an opportunity for operating the most fuel-efficient plants and only a small margin for future growth.

The amount of new generating capacity needed depends upon the level of economic activity. Because the share of electricity is increasing relative to other forms of energy, economic growth is accompanied by an even greater growth in electricity demand. The report shows that current utility plans over the decade are just adequate to replace aging capacity and to support projected annual growth in peak demand of 2.9 percent.

These electricity growth projections reflect a continuation of the sluggish economic conditions experienced in recent years. If the Administration's economic goals were achieved, electricity demand might be substantially greater than the utilities' ability to respond. This story, then, is not about an industry in isolation, but about the economy as a whole and the utilities' ability to support national economic goals.

Walter D. Brown
President, North American
Electric Reliability Council

Floyd L. Culler
President, Electric Power
Research Institute

SECTION 1

Introduction

Electric generating capacity is one of the largest investments made each year in the United States as electric utilities endeavor to build enough capacity to maintain a secure electricity supply. Because capacity is greater than demand, however, some people believe that current capacity levels are excessive and that new capacity additions should be postponed. The use of generating capacity and the reasons for unused capacity are widely misunderstood.

To provide a secure and economical electricity supply over the next decade, utilities are planning new capacity to support economic growth and to replace aging and uneconomical equipment. This planned capacity may not be realized because of financial, regulatory, and environmental problems. Debate continues about the need for new capacity and the effect of delaying or postponing what is planned.

To promote understanding of these issues from a national perspective, **this report addresses the use of generating capacity for supplying today's consumers with electricity, the need for new capacity over the next decade, and the effects of possible delays and cancellations.** The analysis of these issues is supported by data that was submitted by electric utilities to the Department of Energy (Form 119M) and compiled by the North American Electric Reliability Council (NERC).

The main points of this report are illustrated on right-hand pages. These illustrations are available from EPRI as a 35 mm color slide presentation. Narrative and explanatory material appears on the left.

This report addresses:

- **How generating capacity is used to supply today's consumers with electricity.**
- **Whether new capacity planned over the next decade is enough to provide a secure supply of electricity.**
- **How delays and cancellations of planned capacity would:**
  - **—Result in higher electricity costs**
  - **—Threaten the security of electricity supply.**
- **How today's decisions determine electricity supply for the next decade and beyond.**

2.1 Electricity Demand and Capacity in 1981

The illustration shows electricity demand and capacity for the United States as a whole in 1981. This overall view is useful to illustrate important concepts, even though electric power is provided by many individual utilities and power pools.

The total demonstrated capacity for electric utilities in 1981, about 572 gigawatts, is shown by a line near the top of the graph. This line represents the maximum amount of power that could be generated in this country if all power plants were operating simultaneously at their full capability. Demonstrated capacity for each plant is determined by physical testing which is conducted at least twice a year in most states. These tests determine the maximum power that a plant can generate and sustain over several hours. This maximum power aggregated over all plants in the country is the demonstrated capacity shown in the graph. For reference, the largest generating units being built today are about one gigawatt.

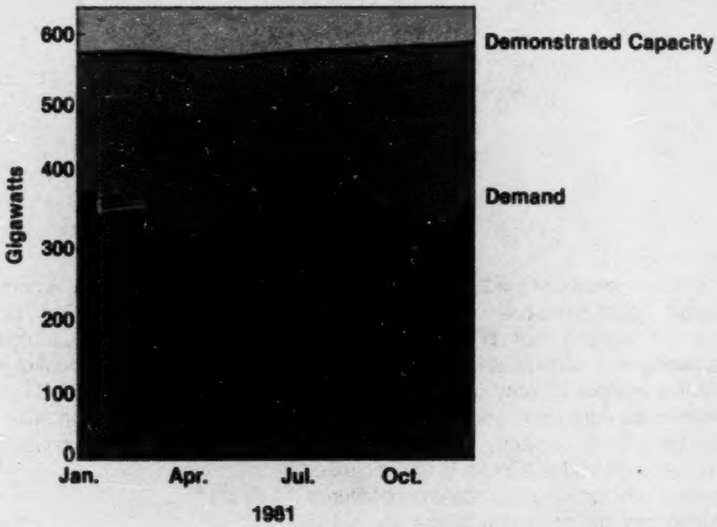
Small variations in demonstrated capacity occur seasonally because of temperature variation and water availability conditions. Thermal plants show higher capacity in the winter than in the summer because lower outside temperatures make their cooling systems more effective. Some hydroelectric plants show more capacity in the spring when water levels are high than in the fall when these levels are low. In addition, the total demonstrated capacity changes during the year whenever a new plant is added or an aging, uneconomical plant is retired. The slight upward slope of the demonstrated capacity line indicates that more capacity was added than was retired during 1981.

Electricity demand fluctuates according to regular daily, weekly, and seasonal patterns. Daily demand is lowest late at night when most people are asleep, and reaches a peak in most areas during the afternoon when residential, commercial, and industrial activities are highest. Weekly, the overall level of demand is lower on weekends when commercial and industrial activity slows down, than on weekdays when it is much higher. Utilities are continuously adjusting their operating capacity levels in order to follow these patterns.

Seasonally, demand varies according to the weather. It is high during the summer primarily because consumers use more air conditioning, and during the winter because they use more lighting and heating equipment. Lower demand during the spring and fall coincides with milder weather conditions. These seasonal effects are clearly evident in the illustration.

The demand illustrated is the sum of

In the summer of 1981, U.S. consumers' demand for electricity reached 75% of utilities' demonstrated capacity.



monthly peak demands over nine regions in the United States. Each region consists of individual utilities with similar weather patterns and operating characteristics. Monthly peak demand in each region is the highest level that demand reached in a particular month. Technically, monthly peak demand aggregated over regions does not represent the true monthly peak demand for the U.S. as a whole, because the regional monthly peaks may have occurred on different days. This curve is a close approximation to the true demand, however, and for illustrative purposes the difference is small enough to be ignored.

In the summer of 1981, U.S. consumers' demand for electricity reached 428 gigawatts, which was 75 percent of utilities' demonstrated capacity. The remaining 25 percent capacity margin was not used to meet demand. A related measure of unused capacity, expressed as a fraction of demand, is called reserve margin. The 25 percent capacity margin for 1981 corresponds to a 33 percent reserve margin. Capacity margin rather than reserve margin is used throughout this study. Because capacity margin is a fraction of capacity, it can be explained in terms of forced outage and maintenance fractions, which are measured on the same basis. This consistency, which facilitates explanation and understanding of unused capacity, would be lost with the use of reserve margin.

Regardless of how it is measured, some unused capacity is needed for a secure electricity supply and some may be desired for economic or other reasons. These topics are discussed in the next few sections.

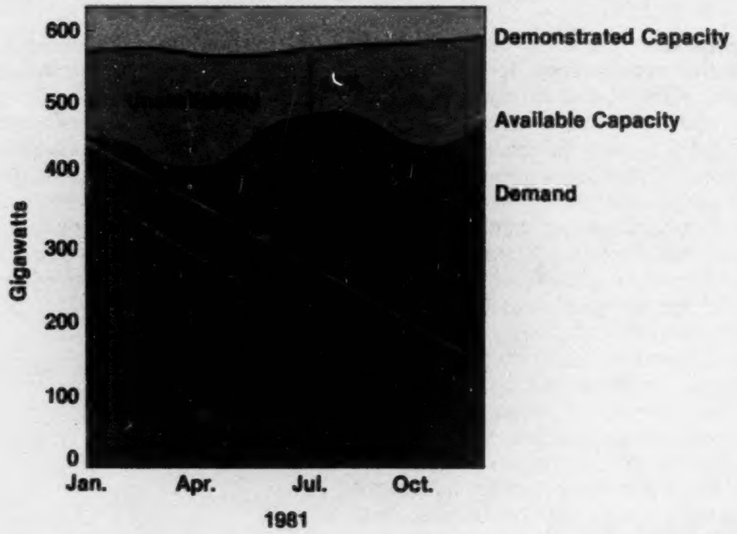
2.2 Unavailable Capacity and Operating Margin

It may appear that the 25 percent capacity margin could have been used to serve increased demand, **but 17 percent of that capacity was unavailable, leaving an operating margin of only 8 percent.** Like all other major equipment and machinery, electric generating capacity requires periodic maintenance and is subject to unanticipated service interruptions and equipment failures. During any month, some plants are out of service and unavailable for these reasons. The remaining unused capacity was available to serve demand, but not needed during 1981. This capacity constitutes an operating margin as shown.

Although the operating margin was not used to generate electricity, it does have important functions. First, the operating margin provides a margin of safety for daily operation. Major equipment failures or sudden demand increases cannot be accurately predicted. To respond to these events and prevent blackouts, part of the operating margin must be held in reserve as instantly available capacity. Second, the operating margin gives utilities flexibility to employ their most economical plants to serve consumers' demand and thereby reduce fuel and operating costs. Without an operating margin, this cost savings is lost because all available capacity would have to be employed.

Because the U.S. is composed of many individual utilities and power pools, the operating margin illustrated is actually an upper limit on the amount of increased demand that could be served. It is not realistic to use available capacity in New England to serve additional demand in California.

But 17% of that capacity was unavailable for service, leaving an operating margin of only 8%.



2.3 Four Causes of Unavailable Capacity

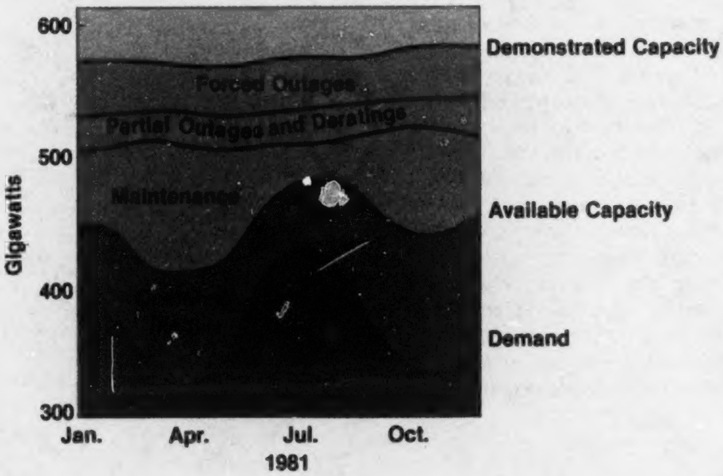
Unavailable capacity resulted from preventive maintenance, forced outages of total plant, forced outages of partial plant and deratings. A forced outage of total plant is a major, unexpected equipment failure that takes a plant totally out of service until it can be repaired. During 1981, about 7 percent of capacity was unavailable across the year due to total plant forced outages.

Partial outages occur when lesser equipment failures, such as breakdowns in mills or pumps, reduce a plant's usable capacity without taking it totally out of service. Deratings are similar reductions in usable capacity. They occur because: poor coal quality makes it impossible to operate a coal-fired plant up to its demonstrated specifications; low water levels prohibit full use of hydroelectric capacity; or unseasonably warm weather reduces cooling system effectiveness. Together, partial outages and deratings averaged 5 percent of total capacity during 1981.

In addition to forced outages and deratings, plants are taken out of service for maintenance on a regularly scheduled basis. This time is used for cleaning, lubrication, replacement of worn parts, and other activities that improve operating characteristics and reduce the frequency of forced outages. Maintenance is scheduled by utilities to take advantage of the seasons when demand is low. During 1981, the least maintenance took place during the summer, and it amounted to 5 percent of total capacity at time of peak.

Because most maintenance is scheduled in the low-demand seasons, the operating margin is roughly constant across the year. Therefore, utilities must be concerned about the security of electricity supply all year long, not just during the season of peak demand.

Unavailable capacity resulted from preventive maintenance, forced outages of total plant, forced outages of partial plant and deratings.



2.4 Recent U.S. Capacity Margins

Capacity margins at the time of peak demand have shown little variation over the last four years. The range for the capacity margins over this period is 23 to 27 percent; 17 to 18 percent for unavailability; and 6 to 9 percent for operating margin. 1981 is a typical year since its percentages are identical to the four-year averages.

Although these averages are stable for the nation as a whole, there are important differences among individual regions, power pools, and utilities. Overlooking these differences can lead to simplistically inappropriate conclusions. Regional differences are discussed in the next two sections.

Capacity margins at the time of peak demand have shown little variation over the last four years.

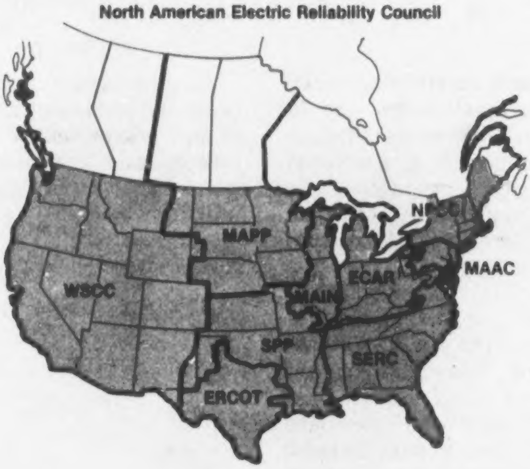
U.S. At Time of Peak Demand	1978	1979	1980	[redacted]	Four-Year Average
Demonstrated Capacity (GW)	527	546	551	[redacted]	
Peak Demand (GW)	393	400	426	[redacted]	
Capacity Margin (%)	25	27	23	[redacted]	25
Maintenance (%)	5	5	5	[redacted]	5
Forced Outages (%)	6	8	7	[redacted]	7
Partial Outages and Deratings (%)	6	5	5	[redacted]	5
Unavailability (%)	17	18	17	[redacted]	17
Operating Margin (%)	8	9	6	[redacted]	8

2.5 Nine Electric Power Regions

U.S. electric supply is provided by many individual utilities and power pools. These individual systems are grouped into nine regional councils. Within each council, the member utilities work together for efficient inter-connected system operations, coordinated planning, and cooperative action in other areas of mutual concern. The nine councils constitute the North American Electric Reliability Council, an organization formed in 1968 to promote the reliability and adequacy of electric power within the United States and Canada.

U.S. electric supply is provided by many individual utilities and power pools. These individual systems are grouped into nine regional councils.

North American Electric Reliability Council



ECAR	East Central Area Reliability Coordination Agreement
ERCOT	Electric Reliability Council of Texas
MAAC	Mid-Atlantic Area Council
MAIN	Mid-American Interpool Network
MAPP	Mid-Continent Area Power Pool
NPCC	Northeast Power Coordinating Council
SERC	Southeastern Electric Reliability Council
SPP	Southwest Power Pool
WSCC	Western Systems Coordinating Council

2.6 Regional Capacity Margins in 1981

Weather, economic conditions, and individual system characteristics lead to substantial regional differences. Although capacity margin for the U.S. as a whole in 1981 was 25 percent, the illustration shows that it ranged from 16 to 31 percent over the nine regions. Unavailability ranged from 10 to 18 percent, and operating margin from 3 to 18 percent.

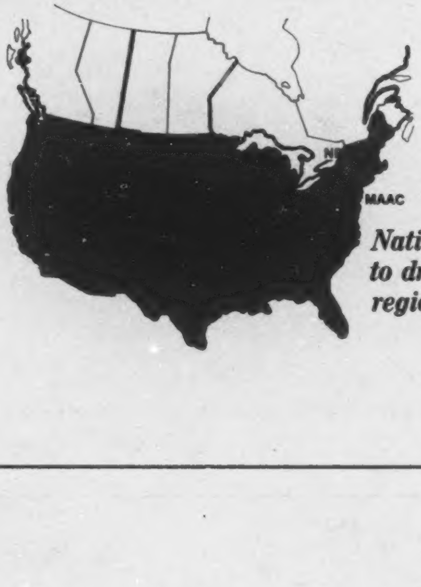
These variations reflect substantial regional differences. The low 10 percent unavailability in the Texas (ERCOT) and Southwest (SPP) regions, for example, was possible because there was very little maintenance at the time of peak demand. Situated in a warm climate, these systems face a high peak each summer because of consumer demand for air conditioning. Since demand in the other three seasons is much lower, utilities have flexibility to schedule maintenance away from the summer peak.

In the Northeast, there is high demand for air-conditioning in the summer and high demand for lighting and heating in the winter. Since the spring and fall seasons are not long enough to absorb all the required maintenance, some maintenance must be scheduled during the summer and the winter. For example, maintenance at the time of peak demand ranges from 4 to 8 percent for the three Northeast regions (ECAR, MAAC, and NPCC).

To understand individual regions, power pools, and utilities requires an understanding of their unique systems and environments. National data should not be used to draw conclusions about specific regions or utilities.

Weather, economic conditions, and individual system characteristics lead to substantial regional differences.

1981	ECAR	ERCOT	MAAC	MAIN	MAPP	NPCC	SERC	SPP	WSCC
Demonstrated Capacity (GW)	90	43	45	41	26	51	117	57	102
Peak Demand (GW)	65	33	34	32	18	36	91	45	77
Capacity Margin (%)	28	23	24	22	31	29	22	21	25
Maintenance (%)	8	0	4	3	3	8	4	0	8
Forced Outages (%)	8	2	15	3	7	4	8	7	4
Partial Outages and Deratings (%)	6	8	2	9	3	6	5	3	4
Unavailability (%)	22	10	21	15	13	18	17	10	16
Operating Margin (%)	6	13	3	7	18	11	5	11	9



National data should not be used to draw conclusions about specific regions or companies.

2.7 Summary of Recent Experience

In summary, meeting consumers' demand is requiring 92% of utilities demonstrated capacity, and operating margin is averaging only 8%. This experience provides a basis for understanding the need for new capacity, which is addressed in the next section.

Summarizing recent experience:

- **Meeting consumers' demand is requiring 92% of utilities' demonstrated capacity.**
    - **—17% is unavailable because of maintenance, forced outages and deratings.**
    - **—75% is available and used to meet demand.**
- **The operating margin is averaging only 8%.**
- **Capacity margins vary substantially across regions because of diverse system characteristics, weather, and economic conditions.**

3.1 Why New Capacity is Needed

Over the next ten years, **new capacity is needed to support economic growth, to provide for aging and retirement of plants, and to reduce dependence on oil and gas.**

Electricity demand growth has consistently exceeded real economic growth in many different industries and for the nation as a whole over the last fifty years. Even with the current efforts toward electricity conservation, toward cogeneration, and toward shifting demand away from peak periods, this pattern is expected to continue [4, 9, 10]. To provide a secure supply of electricity for a growing economy requires building new capacity.

New capacity is also needed to provide for the aging and retirement of generating plants. As plants grow older, they tend to be less efficient, less available, and lower in demonstrated capacity. Eventually, they become so inefficient and expensive that they must be retired. New capacity is needed to replace what is lost due to aging and retirements.

New capacity is also needed to reduce costs. Electricity costs in some parts of the U.S. are higher than necessary due to dependence on high-cost oil and gas. In some cases, it is more economical to convert oil-fired plants to burn coal, a less expensive fuel. In other cases, it is more economical to build new plants, either nuclear or coal, to avoid the cost of burning oil. The amount of new capacity needed for each case is discussed in the following sections.

New capacity is needed:

- **To support economic growth**
- **To provide for aging and retirement of plant**
- **To reduce dependence on oil and gas.**

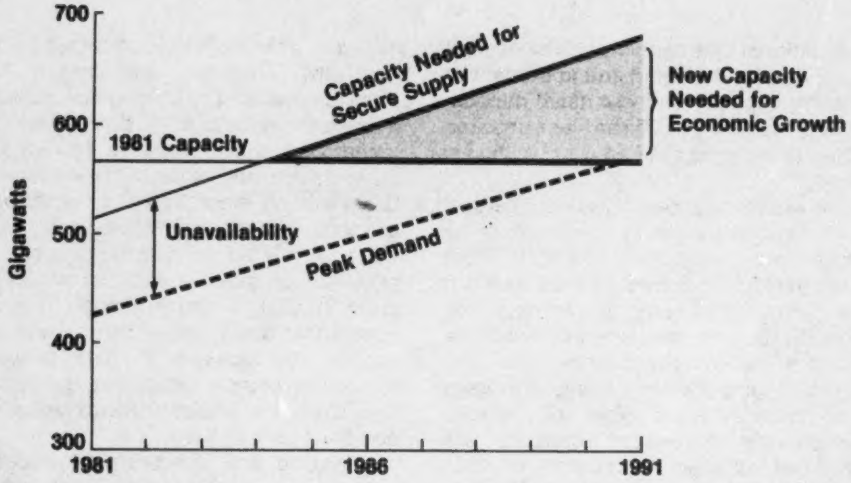
3.2 New Capacity Needed for Economic Growth

The illustration shows the new capacity needed to support economic growth. The broken line indicates peak demand for the U.S. over the next decade, using the 2.9 percent demand growth per year reported to NERC by individual utilities as their forecast [7].

This demand requires an equal amount of capacity, plus, at a minimum, enough additional capacity to provide for unavailability from maintenance, forced outages, and deratings. Allowing for 17 percent unavailability, which is typical of the last several years, provides the minimum amount of capacity needed for secure supply as illustrated.

By the end of the decade, substantial new capacity will be needed to provide a secure supply of electricity for economic growth. It is apparent from the graph that the 1981 demonstrated capacity is enough to provide a secure supply now, and that it will probably be enough for the next few years. Because of economic growth, however, a need for new capacity emerges as early as 1984, and continues to increase through 1991. By 1991 a cumulative 112 gigawatts of new capacity are needed to support economic growth.

By the end of the decade, substantial new capacity will be needed to provide a secure supply of electricity for economic growth.



3.3 New Capacity Needed for Secure Supply and Reduced Cost

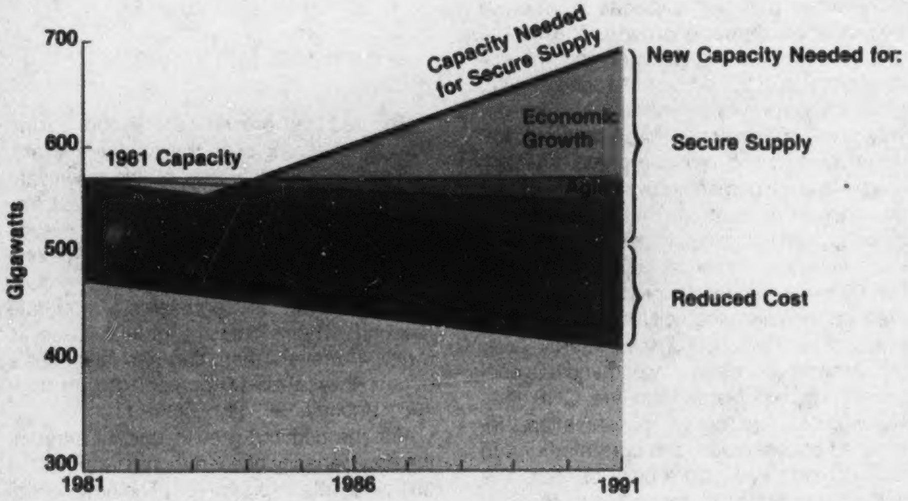
Additional new capacity will be needed to provide for the aging and retirement of existing capacity and to reduce dependence on oil and gas. These needs must be added to the amount needed for economic growth.

The illustration shows that about 5 percent of 1981 capacity will be lost by the end of the decade because of aging. The aging effect varies markedly over different plant sizes and fuel types. Fossil-fueled plants show the most decline over time, whereas hydroelectric and nuclear plants show less. The 5-percent aging effect represents an average over these different types of capacity. Retirements of existing capacity are estimated at about 10 percent of 1981 capacity by the end of the decade. This corresponds to an average plant life of about 50 years because most existing capacity in 1981 was built in the last two decades.

For a secure electricity supply, new capacity must be enough to provide for retirements, aging, and economic growth. The total amount needed for secure supply as illustrated is about 201 gigawatts by 1991. An additional amount of new capacity, either nuclear or coal, would serve to reduce electricity costs by replacing uneconomical oil and gas capacity. While most experts agree that we depend too heavily on oil and gas for electricity generation, the amount that should be replaced by building new capacity is open for discussion. It depends on the capital cost of new capacity, relative fuel prices, and many other uncertain factors. Given existing levels, as well as anticipated additions and retirements, about 90 gigawatts of oil-fired capacity and about 60 gigawatts of gas-fired capacity will be in place in 1991. In the illustration, it is assumed that about half of this oil and gas capacity, 69 gigawatts in 1991, is worth replacing in order to reduce electricity costs. This amount is labeled "Uneconomical Oil and Gas."

Replacing the uneconomical capacity would reduce our dependence on foreign oil and the vulnerability of utilities to fuel supply disruptions. Based on 1981 data, oil used to generate electricity by U.S. utilities is one million barrels per day. Although electric utilities use only 6 percent of the total oil consumed in the U.S., this amount is equivalent to 16 percent of total U.S. oil imports [3]. The oil equivalent of combined oil and gas consumption by electric utilities is over 40 percent of total imports.

Additional new capacity will be needed to provide for the aging and retirement of existing capacity and to reduce dependence on oil and gas.



3.4 How Capacity Needs Depend on Demand Growth

Whether planned capacity is enough depends on demand growth. The middle column in the illustration represents the utility projection of 2.9 percent demand growth, on which the previous illustrations are based. The other columns show capacity needs under increased and reduced growth. Associated with each demand growth rate is a GNP growth rate to illustrate that electricity demand growth is closely related to the level of industrial and commercial activity. During the last 50 years, as energy productivity has increased steadily, electricity demand has increased as a fraction of total energy. Over the same period, electricity demand has consistently grown faster than the GNP [10]. Allowing for increased conservation, increased cogeneration, and current efforts to shift demand away from peak periods, this pattern is expected to continue over the next decade [4, 9, 10]. Since none of our results depends on the precise relationship between demand and GNP, the GNP estimates are just a reminder that the two growth rates are closely linked.

Over the last 25 years, GNP growth rates have been falling [11]. The annual real increase in GNP was:

- 3.9% from 1957 to 1965.
- 4.0% from 1965 to 1969.
- 3.6% from 1969 to 1973.
- 2.8% from 1973 to 1979.

The reduced growth case in the illustration, 1.0 percent over the next ten years, represents a continuation of this downward trend and of the recession of the last few years. The 2.1 percent growth case associated with utility projections is indicative of a sluggish economy. The increased growth case of 3.3 percent represents a moderate rebound. The increased growth case is lower, however, than the Administration's economic goal of 4.0 percent growth from 1981 through 1987 [1, 2, 11].

For the demand growth rates illustrated, the new capacity needed ranges from 180 to 381 gigawatts through 1991. The new capacity currently planned by utilities is near the low end of this range at 200 gigawatts. For perspective, note that each gigawatt may cost 1 billion dollars or more.

Under utility projections, the planned capacity is about enough to provide for a secure supply, but it is not enough to reduce costs as well. Since utilities plan capacity according to their demand growth projections, the 200 gigawatts does not necessarily apply to the increased or reduced growth cases. Under reduced growth, utilities would post-

Whether planned capacity is enough depends on demand growth.

Demand Growth Rate	[redacted]
GNP growth rate	[redacted]
Demand	[redacted]
Unavailability	[redacted]
Capacity needed for secure supply	[redacted]
Existing capacity in 1981	[redacted]
New capacity needed for:	[redacted]
Economic growth	[redacted]
Retirement	[redacted]
Aging	[redacted]
New capacity needed for:	[redacted]
Secure supply	[redacted]
Reduced cost	[redacted]
Needed new capacity	[redacted]
Planned new capacity	[redacted]

pone planned additions as necessary, just as they did during the 1970s. On the side of increased growth, however, there is much less flexibility. Because of the industry's financial condition and because of the multi-year lead times required for licensing and construction, utilities would find it difficult if not impossible to add 300 to 400 gigawatts of capacity by 1991. For the same reasons, even the 200 gigawatts planned is far from certain.

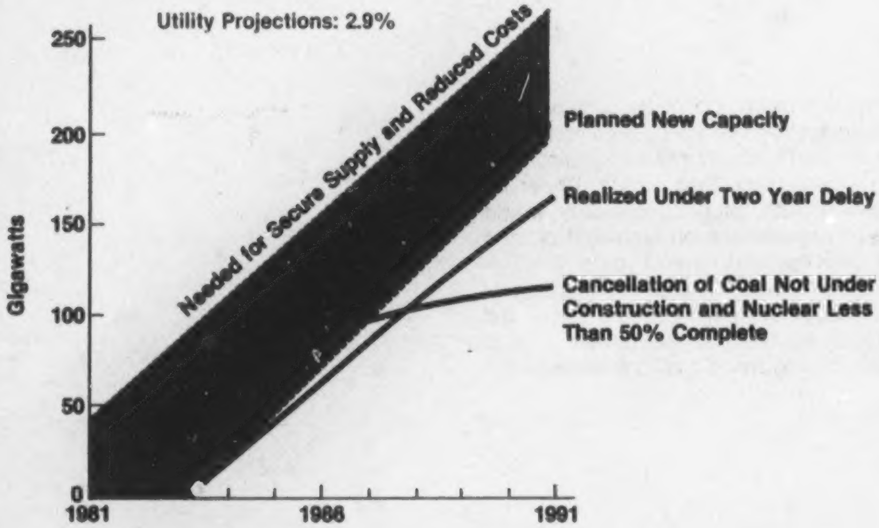
3.5 Capacity Planned and Needed Under Utility Projections

This is the first of three sections that compare planned with needed capacity over the decade. The lower broken line in the illustration shows the minimum new capacity needed for secure supply under utility demand projections. The additional amount needed for reduced costs is shown by the upper broken line. The shaded area between these lines is a reasonable range for capacity additions. Once again, planned capacity for 1991 is enough for secure supply but not enough to reduce costs.

Planned capacity may not be realized because of delays and cancellations. The effect of a two-year delay is shown in the illustration. Such a delay could arise from financial difficulties, regulatory changes or other factors that are beyond the utilities' control. The result is insufficient capacity for secure supply.

If industry financial conditions do not improve, it may be difficult for utilities to add any new investment to their current financial obligations. This case is represented in the chart by the cancellation of all coal plants not under construction and nuclear plants less than 50 percent complete. The result is severe capacity shortages by the late 80's and early 90's. **Delays and cancellations would threaten the security of electricity supply under utility projections.**

Planned capacity may not be realized because of delays and cancellations.

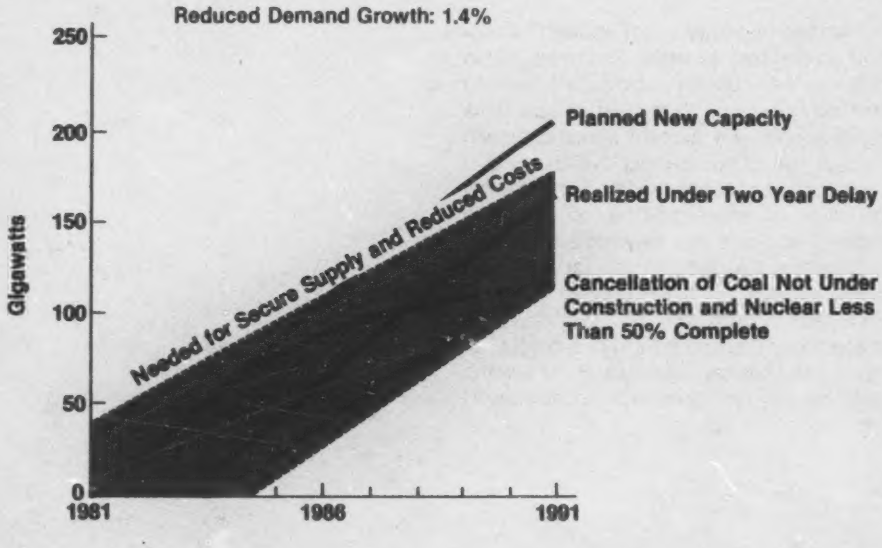


Delays and cancellations would threaten the security of electric supply under utility projections.

3.6 Capacity Planned and Needed Under Reduced Growth

This illustration is identical to the previous one except that the shaded area represents the reduced capacity needs corresponding to 1.4 percent demand growth. **Under reduced growth, planned capacity would lessen dependence on high-cost oil and gas over the next several years.** The two-year delay and cancellation alternatives provide enough capacity for secure supply, and illustrate the flexibility that utilities have to reduce their planned additions as needed.

Under reduced growth, planned capacity would lessen dependence on high cost oil and gas over the next several years.

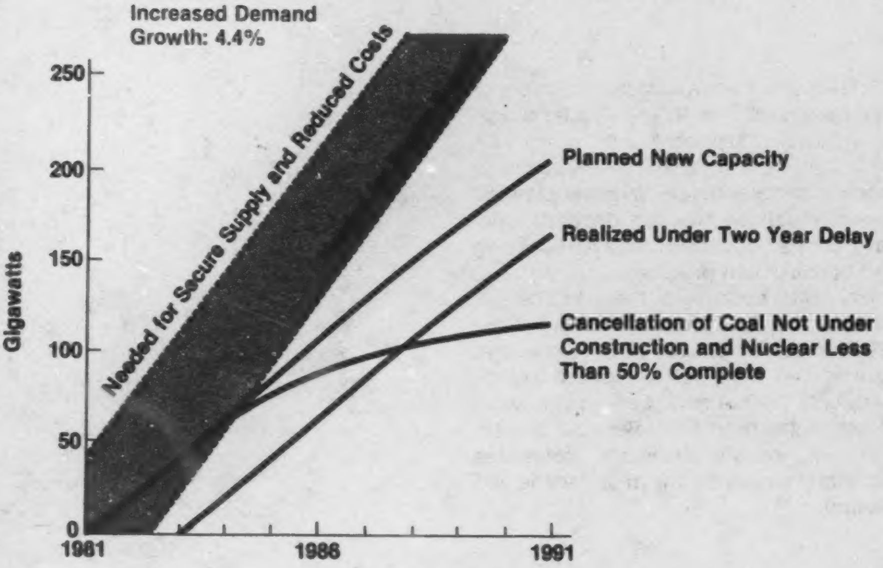


3.7 Capacity Planned and Needed Under Increased Growth

Planned capacity is not enough to support increased growth. Shortages could occur as early as 1984. No adjustments to planned capacity with nuclear or coal units could support 4.4 percent demand growth through 1991, because this level of demand could only be accommodated through installation of short-lead-time oil and gas capacity at a rate that may not be feasible.

President Reagan's target for real economic growth, about 4.0 percent per year from 1981 through 1987 [1, 2, 11], may lead to electricity demand growth of 5 percent or more. The physical resources of the electric utility industry cannot be expected to support this level of growth.

Planned capacity is not enough to support increased growth.

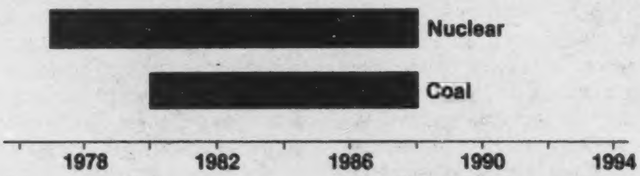


3.8 The Lead-Time Lag

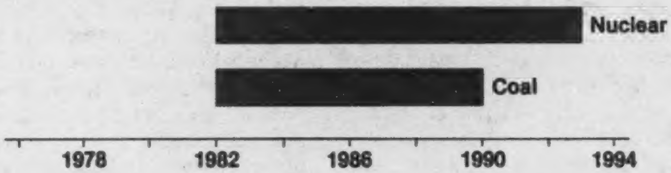
It takes 2 to 4 years to license a nuclear or coal plant, and 5 to 10 years to build one. Consequently, the plants that are planned for the late 80's are already in critical stages of licensing or construction. **Whether planned capacity can be realized depends critically on the success of today's licensing and construction programs.**

Moreover, because of the lead-time lag, **new nuclear and coal capacity for the 1990's must be started now.** A new coal plant started today would probably not be ready until 1990. A new nuclear plant would be completed even later. Because of lead-time lag, **today's decisions determine electricity supply for the next decade and beyond.**

Whether planned capacity can be realized depends on the success of today's licensing and construction programs.



New nuclear and coal capacity for the 1990's must be started now.



Today's decisions determine electricity supply for the next decade and beyond.

■ **Licensing** ■ **Construction**

SECTION 4

Summary and Conclusions

Generating capacity in the U.S. electric utilities is one of the issues of this decade. This special report discusses how this capacity is used to supply today's consumers with electricity and how much new capacity is needed over the next ten years. The discussion is based on present demand projections by utilities and on alternate higher and lower projections.

In the summer of 1981, U.S. consumers' demand for electricity reached 75 percent of our demonstrated capacity. The remaining capacity margin was 25 percent: 17 percent was unavailable for service, and 8 percent was available but not used. Unavailable capacity resulted from preventive maintenance, full forced outages, partial forced outages, and deratings. The 1981 percentages are typical of the last four years. During this time, U.S. capacity margins have shown little variation. National data should not be used, however, to draw conclusions about specific regions or utilities. Weather, economic conditions, and individual system characteristics lead to substantial regional differences.

Over the next decade, new capacity is needed to support economic growth, to provide for aging and retirement of plant, and to reduce dependence on oil and gas. Based on utility demand projections of 2.9 percent growth per year, 270 gigawatts of new capacity are needed by 1991 for these reasons. This needed new capacity is 70 gigawatts more than the 200 gigawatts which utilities are now planning. The planned amount is enough to provide a secure supply, but not enough to reduce costs to consumers through replacement of uneconomical oil and gas. Delays and cancellations of planned capacity would threaten the security of electricity supply.

Actual demand growth is highly uncertain, and may deviate from utility projections. Under reduced demand growth of 1.4 percent per year, planned capacity would lessen dependence on high cost oil and gas over the next several years, and utilities would have flexibility to reduce capacity additions as needed. Under increased demand growth of 4.4 percent per year, planned capacity is not enough. Because adjustments with nuclear and coal capacity to accommodate this level of demand are not feasible, shortfalls would have to be made up by additional oil or gas use. President Reagan's goals for economic growth, which may lead to electricity demand growth of 5 percent or more, are beyond what electric utilities can realistically support.

Whether planned capacity can be realized depends on the success of today's licensing and construction programs. Because the licensing and construction process takes 8 to 12 years for new coal and nuclear capacity, today's decisions determine electricity supply for the next decade and beyond.

In conclusion, **there is not an electricity supply crisis currently but there is a planning crisis.**

There is not an electricity supply crisis currently, but there is a planning crisis.

- **Existing capacity supplies current needs, but provides little room for economic growth.**
- **New capacity is planned to provide a secure supply of electricity for the demand projected by utilities:**
  - **—If demand is lower, planned capacity will reduce costs**
  - **—If demand is higher, planned capacity will not be adequate.**
- **Planned capacity may not be realized. Delays and cancellations would:**
  - **—Result in higher electricity costs**
  - **—Threaten the security of electricity supply under utility demand projections.**
- **Today's decisions determine electricity supply for the next decade and beyond.**

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AMBASSADE DE FRANCE
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L'ATTACHÉ NUCLÉAIRE

WASHINGTON, March 1st, 1983

THE FRENCH FBR PROGRAM

Testimony submitted to the House Science & Technology Committee

Mrs. Chairman :

Breeder reactors, as most endeavours in the nuclear energy field, have been pioneered in the USA. We, French, started an embryonnic program two years after an American breeder had actually generated electricity in Idaho, and the "pool" design which we have so successfully demonstrated in Phénix, and selected for Superphénix and its followers, was first implemented in your EBR2, which is still alive and running after 20 years of operation.

In addition, and this may sound less sweet to your ears, the American have, to develop this technique they had invented, outspent any other country, and by a very broad margin.

Today, however, the largest breeder in operation is Russian, and the largest breeder under construction is European, mostly French. Why have the French, relatively late starters and relatively low spenders, come to share in your leadership of that technology ? I submit it is because their program has been continuous, stepwise, comprehensive and has made the most of the fruitfull interaction of laboratory researches, design teams, and demonstration facilities of increasing scale and scope.

We readily acknowledge how much our program owes to your pionneering, and if you find something to learn from us, it will only be a fair return.

A. The rationale behing FBR development in France

Started right after World War II, but vigourously accelerated after the 74 oil crisis, the French nuclear program has become a major feature of our global energy policy.

In 1982, nuclear reactors have generated 38.7 % of our electricity, while hydropower supplied 26.7 %, and all fossil-fueled station altogether accounted for 34.6 %.

The nuclear share of our electricity was 8.4 % in 1977, we expect it to be 68 % in 1990.

Even before the fact that nuclear power is - by far - the cheapest way to generate baseload electricity in my country, the main incentive to developping it was, and still is, reducing our dependance from foreign energy supplies.

Now, one might wonder if making such a strenuous effort, especially for a medium size country, was worth the trouble, and the answer might be uncertain if nuclear fission were to stay with us only a few decades, leaving us then with depleted uranium mines and filled wastes repositories. But the answer is yes, indeed, if it is to be a long-term source of supply, and only the breeder can actually make the world uranium reserves last for centuries.

Even though your country is much bigger, and your uranium resources far greater than ours, I think you face exactly the same challenge.

B. A continuous program

The following table summarizes the main milestones of the French FBR program :

THE MILESTONES OF THE FRENCH FAST BREEDER PROGRAM

1953	AT FONTENAY-AUX-ROSES, FIRST SODIUM LOOP
1958	OPERATION OF A 600 KW STEAM GENERATOR AT FAR
1958	FIRST SKETCH OF RAPSODIE
1961	AT CADARACHE, TESTING FACILITIES FOR RAPSODIE
1963	FUEL FABRICATION FOR RAPSODIE (CADARACHE)
1964	OPERATION OF STEAM GENERATOR FACILITY AT GRAND QUEVILLY (5 MW)
1965	HARMONIE
1966	MASURCA
1967	RAPSODIE
1968	START OF PHENIX SITE WORKS
1970	RAPSODIE FORTISSIMO (40 MW)
1973	PHENIX
1977	SUPERPHENIX 1 ORDER
1978	START OF SUPERPHENIX 2 STUDIES
1982	SHUT-DOWN OF RAPSODIE
1984	SUPERPHENIX CRITICAL

The main feature of this program is its continuity. Starting from basic and technological studies, proceeding with experimental facilities, to demonstration facilities, and then to commercial sized prototypes. There were no extended "dead-time" period, no cancellation of project already underway, and even if funding has been a limiting constraint on the overall program - forcing us to focus our efforts slightly more so than we would have liked - it has left unscathed the successive mainstream projects.

I cannot over-emphasize the importance of the continuity factor in our success : there is no way we could have kept together those irreplaceable experienced teams of researchers and designers without the renewed motivation of a new and more challenging task to perform.

C. A stepwise program

The "stepwise" quality applies all throughout the program, but it is best exemplified in our "family" of reactors.

Rapsodie, our first "true" FBR, was built in Cadarache between 1962 and 66. This test and irradiation reactor started in 67 with a thermal output of 20 MW, upgrated later to 24, then 40 MW.

It has proven an invaluable tool for component testing in active conditions, then for fuel and materials irradiation. For instance, in 1981, a burn-up of 220,000 MWd/t or 27 % was reached on a fuel pin (when standard maximum burn-up for LWR fuels is 33,000 MWd/t).

Rapsodie has been very reliable : from 67 to the end of 81, its average availability factor has been 73.5 %, and its average load factor, 54.4 %. At the beginning of last year, a nitrogen leak was detected and located. It was decided that, owing to its age, Rapsodie was not worth repairing, and it was shut down. We now expect to learn a lot from its decommissioning.

As soon as 1965, design of a 250 MWe pool type breeder reactor was underway. At the end of 68, after more than one year of successful operation of Rapsodie, construction of Phénix began at Marcoule, on the Rhône river.

Built in five and a half years, within both schedule and budget, Phénix achieved criticality in December 73, and was put into commercial operation by July 1974.

The "vital statistics" of Phénix to the end of December 82, are very impressive :

Total Electricity Production	:	11 billions KWh
Availability Factor since July 74	:	63.6 %
Load factor since July 74	:	58.3 %
Equivalent days at Full Power	:	1892 EFPD
Maximum Subassembly Burn-up	:	100,000 MWd/t

As of today, the operation of Phénix can be considered as a full success, and it has, indeed, been a "Demonstration Plant". It has provided an outstanding experience in the fields of technological development, but also of environmental protection : 85,000 fuel pins have been fully irradiated in Phénix, some of them up to 100,000 MWd/t.

Its actual measured breeding ratio is 1.14, value consistant with the calculations. Its thermal efficiency is 44 %, or even 45 % if we take into account its supply of process steam to the center of Marcoule - as Phénix has been co-generating for years. This means that its thermal releases are even lower than those of a coal fired plant of similar capacity.

It has no liquid effluents, and its gaseous releases are just above the measured background (half a curie per day). Most amazingly, since 1973, total cumulated irradiation doses to all operation and maintenance personnel reaches only 70 man x rem.

Phénix having successfully played its role of demonstration, the next step was to design and build a prototype plant of a size matching present LWRs. The 1200 MWe Superphénix plant, under construction at Creys Malville, is this decisive step in the development of FBRs. It is a joint endeavour of France (51 %), Italy (33 %) and several other European countries led by the FRG. Almost a straightforward extrapolation of Phénix, Superphénix is a multinational plant. Its construction, started in early 1977, is now almost completed.

Commercial operation should begin in the second half of 1984, which represents more than one year of delay with respect to the original schedule. Still, for such an advanced prototype, seven and a half years compare favorably to many construction times of much more classical nuclear reactors, throughout the world.

Each "step" has been scaled up from the previous one, and committed only after the latter's operation had proven successful :

- Rapsodie had - in France - proven the concept,
- Phénix has proven the system, and the reactor design,
- Superphénix will soon prove the feasibility of actually building and reliably operating commercial scale breeders,
- And proving the economic competitiveness will be the task of the "next step", presently under detailed design, and which will have to be committed after a few years of successfull operation of Superphénix.

D. A Comprehensive Program

By qualifying the French program as "comprehensive" I meant to stress that it fully incorporates the development of the FBR fuel cycle, because, inherently, breeders make sense only if their cycle is "closed" and if plutonium recycle does occur.

Plutonium fuel fabrication is carried out in the "Atpu" facility in Cadarache whose size has grown in parallel with the size of the reactors themselves. The first core of Rapsodie was delivered in 66, the first core of Phénix, in 73, and the first core of Superphénix is almost ready today. Cadarache has by now manufactured more than 11 metric tons of plutonium as mixed oxyde, and it is capable of manufacturing the fuel for the next two big plants to be ordered some day ...

The reprocessing has also been demonstrated at corresponding scale : The Rapsodie fuel has been recycled totally at least three times, owing to the reprocessing facility AT1 in La Hague, now decommissioned. The Phénix fuel is reprocessed partly in the Marcoule SAP pilot, partly during some specific campaign in the UP2 LWR reprocessing plant in La Hague. In 1984, a new facility, TOR, will be commissioned to that effect in Marcoule, and will process all the fuel from Phénix and KNK2, the German FBR. More than 12 metric tons of FBR spent fuel have been reprocessed to date in France.

Furthermore, and that is a "world première", the high level wastes coming from the reprocessing of the Phénix fuel have been vitrified in Marcoule, using the process we are presently offering for use to solidify to wastes stored at West Valley.

By "comprehensive", I also mean that the safety R & D and licensing studies have kept in pace with the rest of the program. Most of the safety experiments are carried out in an international framework, many of them in collaboration with the United States.

All the experts now agree - as was very clear in the Lyon international meeting last July - that the safety of breeders is at least equal to the safety of the "classical" reactors. If liquid sodium has a nasty chemical affinity for oxygen and water, it is used without pressure and very far from its boiling point, and the high thermal inertia of the coolant is a trade off for the negative void coefficient.

In all fairness, I must also underline what I do NOT mean by "comprehensive". We have not developped a broad range of alternative solutions for every problem ; quite to the contrary, we have developped one theme, with very few variations ...

Given our limited resources in both budget and manpower, we would have spread ourselves thin trying not to do so. Furthermore, we do not exist in a vaccuum ; should one of our choices of design or material prove to be less than optimal, we know we can rely on alternatives developped in this country or elsewhere in Europe. Our program needs yours, and I am convinced the reverse is true.

E. The Key Role of the Demonstration Facilities

To proceed smoothly, a reactor system development must walk on two legs : a research and development program and the experience gained in the design, engineering and manufacture of actual components. But both legs are not fully symetrical : the body of knowledge piling up in the R & D laboratories, once acquired, remains available even when the researchers have turned to other studies. It is not so for the engineering and manufacturing knowhow, born only out of actual realization. Good engineering teams are perishable goods, that you keep fresh only by having them work on lively projects. Even though you landed man on the moon in 1969, would NASA still exist, were it not for the space shuttle program ?

There is no substitute to building demonstration plants, no matter how large a "base program" you can support.

In addition, the nice thing about demonstration plants is : when they operate, they generate power, and when they are down, they generate knowledge. Incidents in Phénix, for instance, have supplied very valuable informations. Let me just mention two examples : sodium leaks due to thermal cycling stresses have affected the intermediate heat exchangers in 1976, and significantly reduced the power output for two years. But this has served as a demonstration that components of the primary circuit can, if need be, be removed, decontaminated, repaired, and put back into place without any problem, even after several years of operation, and without irradiating the personnel.

Twice during 1982, a leak developped in one of the steam generator (reheater section). Each time early warning was given by the hydrogen detection system, and the reactor was shut down. The first shut down lasted two months, but on the second time, the reactor was back to full power in two weeks. An identical third leak has forced a new shut down on February 15, but the reactor is now back to power. Once feared, we now know that steam/sodium reactions can be routinely handled. You would need a very elaborate experiment, indeed, to be convincing to that degree !

F. In Guise of Conclusion

In conclusion, I will not attempt to draw a parallel between the U.S. and French FBR programs : the very fabric of this exposé incorporates all the necessary hints, without undue subtlety ! But there is another message I can spell out :

Unless a new, yet unknown, source of energy is mastered - that is far from impossible, but we certainly cannot rely on it - we shall all need the breeder some day. Its potential benefits are at the scale of the world energy needs, but developping a fully competitive breeder system will prove no minor challenge either. We are ready, eager, to take our share of that burden, but it is doubtfull that any country, including mine, will dare meet that challenge if yours gives up. We are not unhappy to lead the pack for a few laps, but we won't run alone.

AMBASSADE DE FRANCE
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L'ATTACHÉ NUCLÉAIRE

WASHINGTON February 7, 1983

FAST BREEDER REACTORS - A review of the French program

SUMMARY

First of all, the paper reminds that several deciding factors lead to the introduction of FBR's in the French electronuclear program. The necessity for breeders results directly from the national energetic situation : fast breeders offer the only means of attaining energetic independence, and their commercial development should not be delayed.

Fast breeder reactors have been developed in France since twenty-five years with an uninterruped effort : Rapsodie, Phenix, Super-Phenix are significant steps in this way, concurrently, an important R and D effort is being developed on the associated fuel cycle. An adequate industrial organization has been set up promote FBR's on a national and international scale, in close relation with other European countries working along the same line. On the whole it can be stated that the fast reactor option has proved itself, as regards its technological and industrial maturity.

Then the report deals with the problems which remain to be solved before the widespread introduction of breeders into the energy market. Technically speaking, an important development and improvement work is still necessary, but the main problem in the fast reactor option is to lower its cost. The design of the next breeder reactors is now well under way. The partners in the French program are actively preparing the future and aim at gathering all the technical, economical and financial elements that will enable the government to take, at the appropriate moment GN any decisions pursuant to the program.

In conclusion, the paper points out that France does not intend to develop and to commercialize alone the breeder technology. As shown by the agreements already concluded from 1974 onwards with our European partners, extending the international collaboration in that field in the future can only be beneficial.

1. Rationale behind FBR development in France

1.1. French Energy Situation

In this world, every country is different. France is endowed with a very mild climate, good expanses of land easy to cultivate, enjoyable and widely contrasted landscapes, plenty of ocean costs, etc... We also have an age old culture and many remnants of a sometimes violent but always fascinating past.

On the other hand, we do not have, and never had, cheap and plentiful fossil energy sources (sl. 1) :

No oil to speak of, very little natural gas which is already dwindling away, and a limited amount of very expensive deep underground coal.

Our mountains and river used to offer a good potential for hydropower in the 50s, but now all the promissing sites have been fully equipped, and we can only expect a very modest increase.

In addition, a long tradition of expensive energy, and the short distances associated with a territory smaller than Texas, have made the Frenchman energy-thrifty : for a standard of life not drastically different from yours, we use 2 1/2 times less energy per capita.

I am not complaining about that, but it is all the more painful to conserve energy in my country ; there is very little fat to be trimmed...

As a result, France is a big energy importer : in 1973, before the first "oil shock", we had to import 75 % of the energy we consumed. In 1982, despite strenuous efforts in conservation and nuclear development, our energy dependence has still been 65 %. Such a dependence entails a major political price : we are still too vulnerable to the whims of a handful of producer states, and to the vagaries of the international market.

There is also a high economical price to pay for this dependence : our energy imports amount to 5 % of our GNP, and French citizens send each year more money to supplier states than to the IRS !

1.2. French Energy Policy

To reduce further this energy dependence, our government relies a policy along three main lines :

- continue the improvement in the efficiency of energy use (a better description than "conservation" which seems to imply "waste")
- exploration and development of all the national energy sources
- and, as is now well known, massive implementation of nuclear power.

In January 83 we had 32 reactors in operation, totalizing 23,6 GWe, 27 units (20 GWe) under construction, and 5 more (6.6 GWe) ordered. During this present year, we expect to connect at least six new nuclear plants to the grid. (sl. 2).

From 1977 to 1982, the percentage of French electricity produced by nuclear reactors has jumped from 8 to 40 %. Last year nuclear energy supplied more than 12 % of our total energy consumption, and we should reach 27 % by the end of the decade. At that time, we hope to have reduced our energy dependence to a more menagable 50 %, and almost (sl. 3) all our electricity will come from national sources.

1.3. Uranium Supply for the French Nuclear Program

The emphasis I have (rightly) put on energy independence as a motivation behind our nuclear program bears immediately to mind the question "Ah, yes ! But aren't you trading dependence on foreign oil for dependence on foreign uranium ?".

It is a fact that a program based solely on Light Water Reactors cannot be a definitive answer to the energy dependence problem.

Granted, our national resources are much less negligible where uranium, rather than oil, is concerned : proven reserves amount to 120,000 metric tons of uranium metal, and ultimate resources may come to twice as much.

But by 1990, our 56 reactors will need roughly 10,000 tons per year, and our national production, presently 2,900 t/year, will not exceed 3,500 t/y, which would still exhaust our domestic proven reserves in 30 years or so. Ineluctably, we shall have to increase our uranium imports, and the French nuclear program shall have to rely more and more on those imports.

But, in contrast with the oil situation, we can, and do, take actions which mitigates efficiently this problem :

- we use sparingly our own resources
- we try to diversify our sources of supply
- we maintain a sizeable security stockpile

(the last two items are especially easy in those days where many nuclear programs have collapsed around the world, and uranium can be found, plentiful and cheap).

But those are only medium-term mitigations. The real long term hopes lie in the breeder probram.

1.4. Potential Impact of the FBR

To paraphrase Shakespeare, "to breed or not to breed, ... that is NOT the question", not today. The question is rather to extract from uranium its full energy content, and not only the 1 % that present day reactors, even improved, can do.

Where a closed cycle LWR needs 140 metric tons of natural uranium per year, a LMFBR can produce the same amount of energy from 1.5 tons of natural, or even depleted, uranium. (sl.).

Whether nuclear fission will have been a useful gimmick for a few decades, or a significant source or power for centuries, such is the real challenge behind all the FBR programs in the world.

2. Fast Breeders Development in France

FBR development in France has been the fruit of 25 years of continuous unrelenting efforts. Its main milestones appear on slide...

2.1. Prehistory

First studies started in 1953 on core physics and sodium technology. From 1960 on, major research and test facilities have been concentrated on the site of Cadarache in South Eastern France. First critical assemblies (Harmonie, Masurca) started in 65-66.

2.2. Rapsodie

The first true "reactor" was Rapsodie, built in Cadarache between 62 and 66.

This test and irradiation reactor started in 67 with a thermal output of 20 MW, upgraded later to 24, then 40 MW.

It has proven an invaluable tool for component testing in active conditions, then for fuel and materials irradiation.

For instance, in 1981, a burn-up of 220,000 MWd/t or 27 % was reached on a fuel pin. (It means that every atom of his fuel has been knocked around 170 times !).

Rapsodie has been very reliable : from 67 to the end of 81, its average availability factor has been 73.5 %, and its average load factor, 54.4 %.

Between 79 and 82, Rapsodie has been maintained at the reduced power of 24 MWt to avoid sodium micro leakages. At the beginning of last year, a nitrogen leak was detected and located. It was decided that, owing to its age, Rapsodie was not worth repairing, and it was shut down. We now expect to learn a lot from its decommissioning.

2.3. Phénix

As soon as 1965, design of a 250 MWe pool type breeder reactor was underway. At the end of 68, after more than one year of successful operation of Rapsodie, construction of Phénix began at Marcoule, on the Rhone river.

Built in five and a half years, within both schedule and budget, Phénix achieved criticality in December 73, and was put into commercial operation by July 1974.

Its lifetime behaviour is shown on slide...

It can be summarized in 2 figures :

Total electricity production : 11 billions KWh
Availability factor since July 74 : 64 %
Equivalent days at full power : 1900 EFPD

As of today, the operation of Phénix can be considered as a full success, and it has, indeed, been a "Demonstration Plant".

It has provided an outstanding experience in the fields of technological development, but also of environmental protection :

85,000 fuel pins have been fully irradiated in Phénix, some of them up to 100,000 MWd/t.

Its actual measured breeding ratio is 1.14, value consistant with the calculations.

Its thermal efficiency is 44 %, or even 45 % if we take into account its supply of 2 MW of process steam to the center of Marcoule - as Phénix has been co-generating for years. This means that its thermal releases are even lower than those of a coal fired plant of similar capacity.

It has no liquid effluents, and its gaseous releases are just above the measured background (half a curie per day).

Most amazingly, since 1973, total cumulated irradiation doses to all operation and maintenance personnel reaches only 70 man x rem.

Even its incidents have supplied very valuable informations : Sodium leaks due to thermal cycling stresses have affected the intermediate heat exchangers in 1976, and significantly reduced the power output for two years.

But this has served as a demonstration that components of the primary circuit can, if need be, be removed, decontaminated, repaired, and put back into place without any problem, even after several years of operation, and without irradiating the personnel (all 6 IHX repairs gave a total of 13 man x rems).

Twice during 1982, a leak developped in one of the steam generator (reheater section). Each time early warning was given by the hydrogen detection system, and the reactor was shut down.

The first shut down lasted two month, because of a secondary complication with a nitrogen check valve, but on the second time, the reactors was back to full power in two weeks.

2.4. Superphénix

Phénix having successfully played its role of demonstration, the next step was to design and build a Prototype plant of a size matching present LWRs.

The 1200 MWe Superphénix plant, under construction at Creys Malville, is this decisive step in the development of FBRs.

Almost a straightforward extrapolation of Phénix, Superphénix is a multinational plant. Its construction, started in early 1977, is now almost completed, and for those of you who cannot afford the trip, I will now depict its successive phases :

(slides)

Commercial operation should be declared in the second half of 1984, which represents more than one year of delay with respect to the original schedule. Still, for such an advanced prototype, seven and a half years compare favorably to many construction times of much more classical nuclear reactors, throughout the world.

2.5. The Fuel Cycle

No exposé on FBRs could be complete without covering their fuel cycle, because, inherently, breeders make sense only if their cycle is "closed" and if plutonium recycle does occur.

Plutonium fuel fabrication is carried out in the "Atpu" facilities in Cadarache whose size as grown in parallel with the size of the reactors themselves (slide).

The first core of Rapsodie was delivered in 66, the first core of Phénix, in 73, and the first core of Superphénix is almost ready today.

Cadarache has by now manufactured more than 11 metric tons of plutonium as mixed oxyde, and it is capable of manufacturing the fuel for the next two big plants to be ordered some day...

The reprocessing has also been demonstrated at corresponding scale :

The Rapsodie fuel has been recycled totaly at least three times, owing to the reprocessing facility AT 1 in La Hague, now decommissioned.

The Phénix fuel is reprocessed partly in the Marcoule SAP pilot, partly during some specific campaign in the UP2 LWR reprocessing plant in La Hague.

More than 12 metric tons of FBR spent fuel have been reprocessed to date in France.

Next year, a new Pilot called TOR will begin operation in Marcoule, with a dual purpose :

- Closing the cycle of Phénix and KNK2, with a capacity of 5 tons per year
- Testing in full scale and in active conditions the components of the next dedicated FBR reprocessing plant. To this purpose, TOR will reprocess some of the Superphénix spent fuel.

2.6. Industrial Organization

FBR development is assured by a limited number of companies, which share a common goal but have very specific parts to play ;

- Electricité de France (EdF) is the Architect engineer and operator of the plants.
- Commissariat à l'Energie Atomique (CEA) is the promotor and licensor of the system, and responsible for R & D.

- NOVATOME is the NSSS designer and supplier.
- COGEMA is responsible for the fuel cycle (fabrication, reprocessing & wastes vitrification).

Novatome was incorporated in 1976, it holds the CEA licence for the FBR system. Its engineering team has developped an outstanding competence in the field of FBRs.

Since 1981, Novatome is a 70 % subsidiary of Framatome, the French NSSS vendor for PWRs.

But this is only the "French" side of the story. As you know, starting with Superphénix, the French FBR program has become more and more international.

(slide)

NERSA, the owner, Architect, and operator of the plant is a joint venture of EdF (51 %), ENEL (33 %) and SBK (16 %).

The NSSS supply contract has been awarded jointly to Novatome and NIRA, which have spread sub-contracts all over the three countries involved (60 % France, 30 % Italy and 10 % Germany).

In addition, since 1977, French and German have pooled all their experience in FBR, and transferred the know-how to the joint SERENA "system" company, which gave the full license both to Novatome and the German consortium INB.

3. Conclusion (and prologue...)

At this point I would like to draw both a conclusion and a prologue :

The French program of FBR development has been, up to now, characterized by 2 main features : continuity and progressiveness. It has developped step by step, but without interruption.

Before each realization, extensive full scale tests have been performed, and the fuel cycle has not lagged behind reactor development.

This prudent approach has enabled us to maintain competent technical teams, and suitable facilities, making a maximum use of our large but limited budget.

Even though full confirmation will only be given by the actual operation of Superphénix and TOR in the very near future, one can reasonnably assert that technically the breeder has proven itself, up to full commercial scale.

But it is only a beginning. Significant improvements in both power plant and fuel cycle facilities are still needed to reach economic competitiveness. The very depressed uranium market which reduces everybody's feeling of urgency about breeder deployment, increases dramatically the need to prove this competitiveness, and this is the battle which begins now.

The CEA, EdF and Novatome are presently engaged in the detailed design of a 1500 MWe advanced breeder, closer to economic competitiveness in order to have a full project ready by 1986, if at this date the French government authorises EdF to place such an order.

In addition, a special team of bright young people has been assigned the longer term job of designing for the 90s "the" competitive breeder, and to pilot the R & D programs to that end.

But we do not intend to proceed alone. Our past experience of collaboration with the Italian and German has proven too valuable, and the costs of pursuing alone such a development, too expensive for a medium size country. The prospect of mastering a quasi inexhaustible source of energy remains as vivid as ever, and if the need appears less urgent, this gives us more time to cooperate, and refine the final product.

ELECTRIC POWER RESEARCH INSTITUTE

EPRI

March 28, 1983

The Honorable Marilyn Lloyd
Chairwoman, Energy Research
and Production Subcommittee
Committee on Science and Technology
U.S. House of Representatives
2334 Rayburn House Office Building
Washington, D.C. 20515

Dear Madam Chairwoman:

This letter is in response to the request of your staff that we review and comment on the U.S. Department of Energy's (DOE) planning in Light Water Reactor (LWR) safety-related R&D. DOE has been most cooperative in supplying us with information on their planning. We have attempted to provide positive suggestions for improvement and encouragement for DOE activities in some areas.

To respond to the requirements of Public Law 96-567, "Nuclear Safety Research, Development and Demonstration Act of 1980" (NSRD&D Act), DOE established a number of working groups with government and industry membership to help in the evaluation of safety R&D and to respond to the Act's evaluation requirements. The Electric Power Research Institute (EPRI) participated in all of these groups except those concerning training and operational matters within the charter of the Institute of Nuclear Power Operations (INPO).

DOE has developed, using reports of the individual evaluations of several of these working groups, a draft report titled "Issues and R&D for Improved Assurance of Radionuclide Containment in Light Water Reactors." We have provided DOE with comments on the report and have been assured by DOE that positive action is being taken on the comments, particularly our three major points. As a result of our comments (and perhaps those of others), we expect that the final report will be improved as follows:

(a) There will be defined specific programmatic content with a clear indication as to how the R&D monies DOE would spend would be utilized to improve the present on-going NRC, DOE, and EPRI safety R&D programs.

(b) The Federal Safety R&D budget does not appear to need the additional large amount of money originally proposed as an incremental increase in the DOE budget and this will be resolved positively by a better prioritization and focusing of efforts within the present program level.

(c) The relationship of DOE-proposed R&D to the parallel NRC R&D program as documented in the Severe Accident R&D Plan, NUREG 0900, will be documented, so that it can be better coordinated with the NRC.

This report, in the modified form we anticipate, highlights a most important issue in safety R&D: the importance of defining a more realistic "source term"(1) for the evaluation of public risk in the event of a severe reactor accident. Increasingly strong evidence is accumulating that a more realistic source term is much less than the source term now used in reactor regulation and emergency planning.

NRC has established a substantial R&D program, documented in NUREG 0900, to develop a more accurate source term. NRC has recently increased the priority of this work and established a schedule which projects a re-evaluation of emergency planning guidance and application of new source term data in 1983. The NRC plan also projects the establishment of a revised final source term by the end of government fiscal year 1985.

EPRI also has a high priority R&D effort on the source term and on the basis of the work done to date by the many organizations involved, judges that an interim source term of 1/10 or less than the values now used in regulation may well be substantiated. It is also judged that the additional work through 1985 may well substantiate a source term reduction to a value much smaller than 1/10.

The NRC and EPRI, as well as international, R&D planned to substantiate a final source term involves, as an important component, a series of integral experiments in reactor test environments which will confirm accident evaluations developed from many separate effects experiments.

This suggests a role for DOE in carrying out the remaining R&D necessary to define a final source term, involving five significant supporting efforts:

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(1) "Source Term is defined as the ratio of the amount of a given fission product specie available for dissemination outside containment to the total amount of that specie in the reactor core.

(1) DOE can take the lead in the area of containment failure modes under severe accident situations. Failure mode is a key parameter in risk and consequence evaluations. In simple terms, if the containment remains intact longer, or if the break in containment is smaller than presently assumed, then the off-site dose to the population (consequences) will be considerably reduced. The recent Zion/Indian Point study which indicates a longer time-to-failure is appropriate for many containment systems. Even more recent is the concept that a "large" containment failure is significantly smaller than previously envisioned. Containment issues have been given a high priority by the DOE report, and DOE can help to resolve the containment failure mode questions on a timely basis.

(2) We agree with the DOE report's assessment of the importance of fission product behavior in and around the core during a postulated melt-down scenario for source term definition. A number of projects are already started in this area, however, and it is not clear that additional ones are required. The most effective approach for DOE in this area would be to augment programs already underway where additional work is desirable. One such program is EPRI's Source Term Experimental Program (STEP) being conducted by Argonne National Laboratory (ANL) in the TREAT facility. The DOE approval to use the TREAT facility is greatly appreciated by EPRI, and EPRI would welcome direct participation by DOE in STEP in a way which would allow increasing the number of planned tests. We feel that DOE assistance in the source term area is one of the most important items in the DOE program to assist LWRs other than the back-end of the fuel cycle.

(3) EPRI's STEP program concentrates on one technical aspect of the source term definition. Additional timely experiments are needed to supplement the EPRI funded work. The U.S. NRC is proposing a Phase II set of experiments on degraded core behavior in the PBF facility. Originally the EPRI staff was skeptical as to the usefulness of these tests. EPRI and NRC have had an ongoing technical discussion, and the planning for these tests is now firming up. As an outcome of these technical exchanges, NRC and its contractor, EG&G, have made a series of changes which we view as a significant improvement in the proposed experiments.

While there remains some technical aspects of these tests to be worked out, it is our judgement that the focus of these tests on fission products and fission product aerosol behavior is in the correct technical direction. These PBF tests, as they are currently evolving, are viewed as an important complement to the type of tests to be conducted in EPRI's STEP program. The NRC faces a technical challenge in executing these tests in a way to maximize the useful information. We expect to continue the dialogue with the NRC on a technical level to optimize the result of our programs.

(4) DOE now has responsibility for a redirected program in the LOFT facility and has put forth efforts to bring international participation to LOFT. An OECD consortium has been formed, which provides the DOE with significant foreign financial support and technical input. EPRI supports the OECD LOFT consortium project based on our desire to get source term related information for a nuclear reactor system as part of the test series. LOFT has a unique character compared to all proposed facilities for source term experiments. It consists of an entire system--core, loops, pumps, pressurizer, steam generator, etc. The high temperature fission product release test proposed as the last test in the OECD LOFT consortium test series is an important test to be conducted in the test series. EPRI strongly urges DOE to bring its resources to bear so that this test can be accomplished successfully. EPRI recognizes the technical challenge, but we feel that INEL engineering talent and the Idaho Operations Office can be instrumental in bringing this experiment to a successful conclusion.

(5) DOE should continue vigorously with its R&D program on the TMI-2 plant to extract data of generic value to nuclear power safety. Data from inspection of the damaged core will be of particular relevance to an evaluation of the source term. Other important data on safety equipment survivability and decontamination will also be obtained.

In summary, DOE can play a key role in LWR Safety R&D by contributing to the source term resolution. EPRI would encourage DOE participation in EPRI's STEP program to the point where additional tests can be conducted. These early tests are complementary to the NRC Phase 2 tests proposed for PBF. EPRI supports NRC's efforts to complete the technical definition of, and implementation of, the PBF Phase 2 tests. DOE's leading role in the OECD LOFT project is encouraged, expecially their efforts to make the high temperature fission product release test a success.

By implementing the programs as outlined above, DOE would provide coordinated, major support to the NRC severe accident R&D program which has as a major goal the definition of a more realistic source term.

Sincerely yours,

John

John J. Taylor, Director
for Nuclear Power

JJT:bg

cc: Shelby Brewer, DOE
Jerry Griffith, DOE
Robert Minogue, NRC

Westinghouse Electric Corporation

Advanced Power Systems Divisions

J B Yasinsky
General Manager

Nuclear Center
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March 30, 1983

Mrs. Marilyn Lloyd Bouquard
Chairman
Subcommittee on Energy
Research & Production
U. S. House of Representatives
Committee on Science and Technology
Suite 2321 Rayburn House Office Building
Washington, D. C. 20515

Dear Mrs. Bouquard:

I am pleased that my testimony led you to further inquiries. Your questions are very penetrating and very appropriate; the answers are appended. I hope you don't mind my answering them in the reverse order; it simplified my thought processes.

Sincerely,

Attachment

QUESTIONS AND ANSWERS

- Please discuss in general terms some ways to make the next breeder plant (beyond CRBR) commercially attractive (e.g., standardization in design).

As you know, Westinghouse-funded efforts to design a low-cost target plant have had some success, and have been popularized in the trade press (Energy Daily, Power Engineering) as the "VW" Breeder. That target plant showed that a LMFBR capital cost comparable to that of a light water reactor was feasible, justifying our belief that the breeder can be cost-competitive without a marked increase in U_3O_8 cost. In addition to expected benefits not related to design (such as a large service industry which results in less plant capital investment for maintenance facilities), a number of design features were unveiled which reduced costs: a duplex-tube steam generator, piping bellows, containment cells, dedicated decay heat removal systems, and simplified reactor internals/fuel handling design. Many of these ideas are now being considered in DOE's Large Scale Prototype Breeder (LSPB) design, and will make it more commercially attractive.

In general terms, the target plant design can be said to have resulted from designing an ultimate plant to meet form, fit, function and true safety, rather than continuing to apply the design conservatism that prudent engineering requires in an early plant. But one must not be deluded. There are some features suitable in a target plant that are not suitable for a first plant (such as minimal maintenance features), and some features that should be in a first plant (such as extensive instrumentation) that are unnecessary in a target plant. Further study of these features is underway in DOE's Base Technology program.

- Do you believe that the Administration's proposed FY 1984 Breeder Reactor program is adequate? Please identify any areas of concern to you.

To the extent that the Administration's FY 1984 Breeder Reactor program includes adequate funds for continuation of CRBRP, it is adequate. To continue the flow of knowledge from CRBRP to successive plants, however, it is necessary to take advantage of the same design team (this is what the French have done, from Rapsodie thru Phenix to Superphenix). The best way to do so is to transfer personnel from CRBRP to LSPB design as their roles on CRBRP wind down. This will also serve to fill the dangerous lacunae that could otherwise exist just prior to CRBRP operation, when debugging will require the attention of CRBRP designers who would otherwise have left the LMFBR program years before. So, it would be advantageous to propose legislation similar to that you proposed several years ago, combining the CRBRP and LSPB project personnel and funding - building up the LSPB staff as CRBRP needs decrease. This will not require much in additional FY 1984 funds (perhaps $5,000,000), but it will establish a commitment to retention of the CRBRP design team on the next plant.

- What impact, if any, does the breeder development program have on aiding the recovery of the nuclear industry to a healthy status?

Although there is now a reduced demand for light water reactors, and consequently a depression of U_3O_8 prices, there can be no question that U_3O_8 prices will rise - nor that economical supplies of U_3O_8 prices will be exhausted; the only question can be when.

Some electric utility executives have said they will not buy another light water reactor unless they know breeders will be developed. They need the breeder as an insurance policy. Without it, some will forego investment in light water reactors.

The breeder is an insurance policy - both to provide a future source of fuel for light water reactors and to provide a cap on U_3O_8 prices, while avoiding massive mining by using stockpiled tails. Knowledgeable people can argue about how soon the breeder will be needed, just as they can argue about how early in one's life one should buy a life insurance policy. But prudent people buy insurance policies!

- Is the DOE goal to terminate federally-supported R&D subsequent to the completion of the Large-Scale Prototype Breeder plant realistic?

Reactor design is evolutionary. As stated above, one cannot have, in the first plant, all the features of the ultimate plant. Between the two there will be extensive financial risk-taking by the private sector, which will be instituting changes to reduce operating cost and improve performance. In the same way, continued R&D support can also be cost-beneficial for the nation. For example: hockey-stick steam generators are used in CRBRP because they are the most tested and most reliable available. One need not wait for better ones. But units now being developed in a federally-supported R&D program could eliminate the $50,000,000 sodium-water reaction products system now in LMFBR plants. Further steam generator R&D could eliminate $300,000,000 intermediate systems in each plant. Steam generators are but an example. Others, such as continued development of better fuels (advanced oxide, carbide), safety R&D, etc., also spring to mind. Development of such programs seem to be appropriate federal R&D investments.

NRECA NATIONAL RURAL ELECTRIC COOPERATIVE ASSOCIATION
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March 29, 1983

Honorable Marilyn Lloyd Bouquard
Chairman, Subcommittee on Energy
Research & Production
Committee on Science and Technology
House of Representatives
Suite 2321, Rayburn House Office Building
Washington, D.C. 20515

Dear Mrs. Bouquard:

This is in reply to your letter of March 23 in which you request that we supplement testimony regarding the DOE Breeder Reactor Program for Fiscal Year 1984. We have set forth each of the two questions asked, followed by our response.

We hope this information will be helpful to you. If we can be of further assistance, please let us know.

Sincerely,

Morgan D. Dubrow

Morgan D. Dubrow
Senior Staff Engineer
Energy and Environmental
Policy Department

Enclosure

ADDITIONAL QUESTIONS
NRECA

o What role does the Breeder R&D program play in sustaining or revitalizing the nuclear electric power option in this country?

Answer

NRECA feels that the Breeder R&D program is essential if we are to sustain and revitalize the nuclear electric power industry. We respectfully point out that in this age when technological advancement is so vital to the future of this nation, we should not be debating the efficacy of competing with other world powers in the development of high technology in the energy field. That is one of the key issues in the question of whether or not to proceed with completion of the Clinch River Breeder Reactor. Aside from the point of energy independence and providing abundant energy sources for the future, we must face the issue of whether or not we are going to pull back from the investment we began more than 10 years ago in developing nuclear power resources and let other nations leave us behind, or if we are going to maintain leadership in this crucial field of industry and commerce.

The Breeder Reactor Program and its centerpiece--the Clinch River Breeder Reactor Project--is needed to demonstrate the liquid metal fast breeder reactor process. France, Great Britain and the Soviet Union have built and been operating LMFBR demonstration plants since the 1970s. West Germany is now building an intermediate size demonstration plant, and Japan has one on the drawing board.

It would seem unwise for the United States at this juncture to take the position, in effect, that further investment in the development of the breeder concept be abandoned. We cannot turn our backs on the 250,000 tons of uranium tailings in stockpile--the energy equivalent of all U.S. coal reserves, or more than all the oil reserves of the OPEC nations. Plant design is more than 86 percent complete. Research and development is 96.5 percent finished. Around $700 million worth of equipment has already been purchased or is on order.

These are some of the reasons that the Clinch River Project is an essential advance in our technology which must precede commercial development of breeders by the United States. The utility industry believes this effort is necessary to the goal of energy independence.

- From the utility industry's viewpoint, please discuss the requirements of a breeder reactor necessary to make it a commercially attractive and viable electricity supply option.

Answer

The NRECA believes that making a breeder reactor a commercially attractive supply option depends on the continued orderly development, construction and operation of the Clinch River Breeder Reactor Project. This will provide the domestic capability to take the next step, namely, to scale up Clinch River to a commercial size LMFBR with a capability of 1200 to 1500 megawatts. In our view, this is the only way that the electric utility industry can be assured of having a commercially available breeder which meets our health, safety and environmental standards. These must of course be met if we are to have available for domestic use nuclear breeder reactor power plants that can be licensed, built and operated successfully.

Finally, the commercialization of the breeder is essential because it permits the use of the existing stockpile of uranium, thereby assuring an adequate supply of electricity for centuries.

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ROBERT B. RICHARDS—GENERAL MANAGER
ADVANCED REACTOR SYSTEMS DEPARTMENT
NUCLEAR FUELS AND SPECIAL PROJECTS DIVISION

April 11, 1983

Marilyn Lloyd Bouquard, Chairman
Subcommittee on Energy Research
& Production
U.S. House Of Representatives
Committee on Science & Technology
Washington, D.C. 20515

Dear Marilyn:

Thank you for the opportunity to respond to the important questions you pose on the breeder's development. In addition to answers to these specific questions I have attached a brief presentation we have prepared on the need for a more comprehensive breeder program.

My many years in the nuclear industry and involvement in the breeder's development lead me to believe the breeder is our best and possibly only means to cap our rising energy prices before energy becomes an insurmountable obstacle to the economic growth we require. Over the past decade energy expenditures as a percentage of our gross national product have doubled and are rapidly approaching 20 percent. If we were to wait until some of the popular alternatives become "economic", our energy bill could approach 30 percent of our entire GNP. That this, or anything approaching it, would spell economic disaster should be obvious to all.

The liquid metal fast breeder has at least two characteristics that, if properly exploited, can solve some of the major problems with nuclear power costs. The high temperature liquid metal coolant provides the potential of removing the reactor's shutdown heat without auxiliary systems or activation of pumps or valves. The low pressure of the coolant allows a smaller, close coupled containment that serves to assure the core will not be uncovered. These features, along with other possible advancements, promise to make the breeder cheaper than our current nuclear plants while still providing a stable, cheap fuel cost for centuries.

We fully appreciate the problems of funding such a large developmental effort as the breeder at this time. The easy route would be to ignore the future but this would merely prolong our uncertainties over energy security and lose the technological capabilities we have developed over the past 35 years. Therefore, in spite of the difficulties I urge you to continue with your efforts to preserve and advance this important energy option.

Sincerley,

R. B. Richards

R. B. Richards

R. B. Richards
April 11, 1983

QUESTION #1

Is the DOE goal to terminate federally-supported R&D subsequent to the completion of the Large-Scale Prototype Breeder plant realistic?

ANSWER

NO. The breeder option cannot be developed in the United States without federally supported R&D and federal support of a commercial prototype. However, the design of this prototype is uncertain today. Several new, promising concepts have been proposed. These efforts toward a more economic breeder should be expanded and evaluated before selection of an approach for the commercial prototype.

QUESTION #2

What impact, if any, does the breeder development program have on aiding the recovery of the nuclear industry to a healthy status?

ANSWER

With verification that the new advanced breeder concepts can meet to a reasonable degree their established goals and objectives, the breeder could be the means of reviving the nuclear industry.

QUESTION #3

Do you believe that the Administration's proposed FY 1984 Breeder Reactor program is adequate? Please identify any areas of concern to you.

ANSWER

NO. This program should include an advanced breeder category to fund and advance new concepts that promise solution to (1) the high cost of plant construction (2) the high financial risks the utilities face with nuclear plants and (3) the high costs of developing and demonstrating a new nuclear concept.

QUESTION #4

Please discuss in general terms some ways to make the next breeder plant (beyond CRBR) commercially attractive (e.g., standardization in design).

ANSWER

1. Minimize the field nuclear quality work by building preassembled components in the factory and shipment of these quality assured components to the site for installation.
2. Design the nuclear heat supply to be inherently protecting without reliance on connecting systems or any power supply.
3. Prove the plant safety features with demonstration and revamp the licensing criteria based on tests rather than analyses or institutional opinions.

ADVANCED BREEDER DEVELOPMENT

DRAFT
B. BLUMBERG
MARCH 24, 1983

ADVANCED BREEDER NEED

- OIL COST DROPPING BUT COSTS STILL HIGH AND DOMESTIC RESOURCES LIMITED
- GAS COSTS RAPIDLY APPROACHING CURRENT OIL COSTS
- ELECTRICITY PRICES RISING AT RATE DOUBLE THAT OF INFLATION
- ELECTRICITY FROM NEW NUCLEAR AND COAL PLANTS REQUIRE ADDITIONAL PRICE INCREASES
- RISING ENERGY COSTS ARE NOT CONDUCIVE TO ECONOMIC GROWTH

NEW SYSTEM AND NEW APPROACH NEEDED
TO STOP ENERGY COST ESCALATION

ADVANCED BREEDER OBJECTIVES

- BREEDER WILL PROVIDE LOW, STABLE FUEL COST FOR CENTURIES BUT:
- BREEDER MUST SHOW PROMISE OF REDUCED CONSTRUCTION TIMES AND LOWER PLANT COSTS
  - PLANT COST EQUAL TO OR LESS THAN CURRENT NUCLEAR SYSTEMS
  - CURTAILMENT OF THE CURRENT REAL COST ESCALATION OF NUCLEAR PLANTS
  - REDUCTION IN CONSTRUCTION TIMES TO 5 OR 6 YEARS
- DEMONSTRATION NECESSARY BUT COSTS MUST BE REASONABLE
  - PROGRAM REQUIRES SEQUENTIAL ADVANCEMENT TO STANDARD, ASSURED PRODUCT
  - DEMONSTRATION MUST PROVE SAFETY AND LIMITED FINANCIAL RISKS
  - DEMONSTRATION FINANCING MUST BE A JOINT INDUSTRY/GOVERNMENT EFFORT
  - DEMONSTRATION COSTS MUST BE IN MILLIONS RATHER THAN BILLIONS

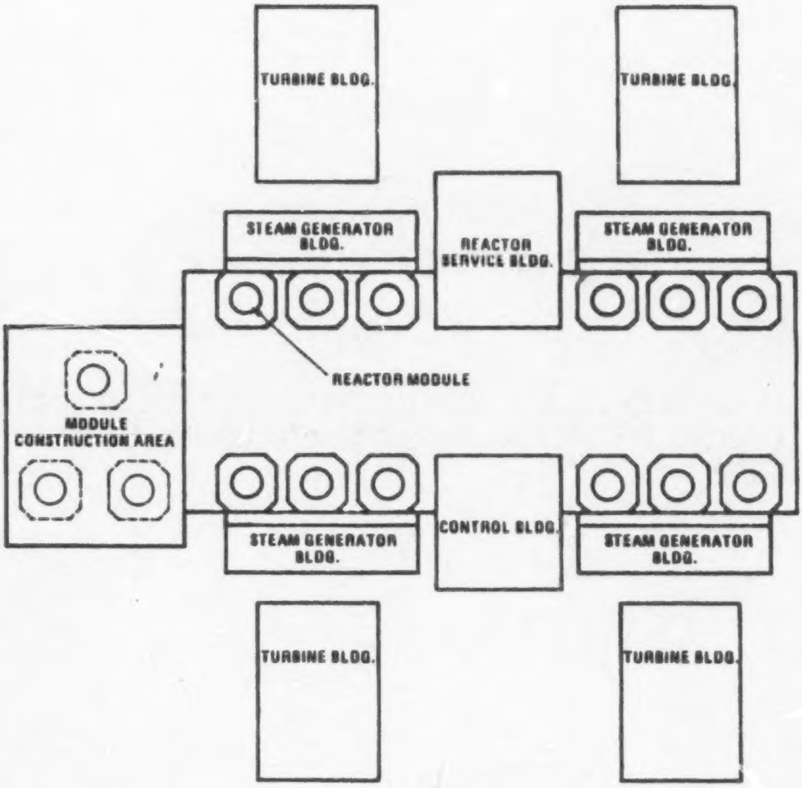
ADVANCED BREEDER MUST SHOW NEAR-TERM PROMISE OF CAPPING THE REAL COST ESCALATION OF ELECTRICITY PRODUCTION WITH REASONABLE DEVELOPMENT COSTS

THE MODULAR BREEDER REACTOR (MBR)

- AN ADVANCED CONCEPT DIRECTED TOWARD SOLUTION OF CURRENT PROBLEMS RESTRICTING NUCLEAR GROWTH AND USE OF THE BREEDER

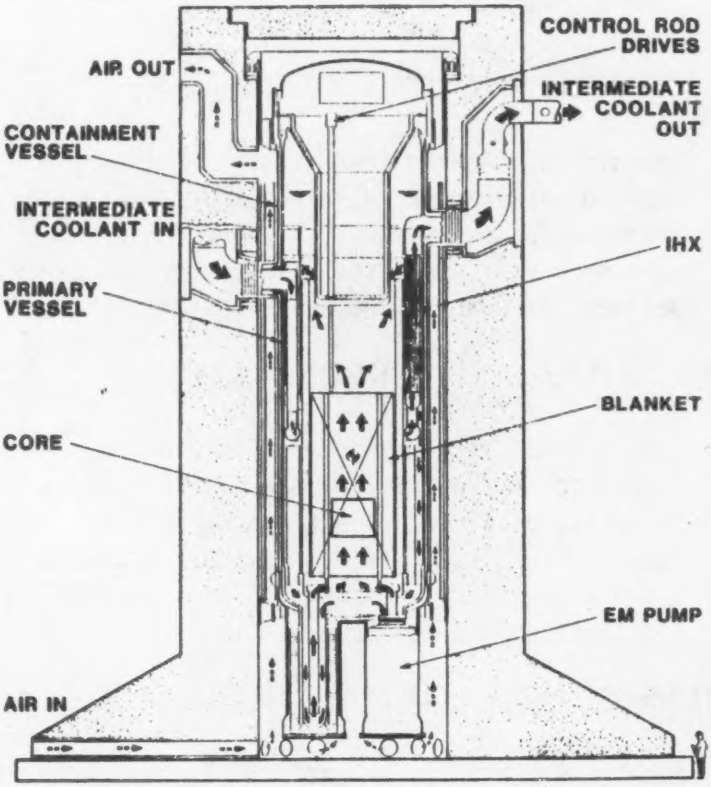
FACTORY PRODUCED, SHIPPABLE
FAIL SAFE

MODULAR BREEDER
PLANT LAYOUT


TURBINE BLDG.
TURBINE BLDG.
STEAM GENERATOR BLDG.
REACTOR SERVICE BLDG.
STEAM GENERATOR BLDG.
REACTOR MODULE
MODULE CONSTRUCTION AREA
STEAM GENERATOR BLDG.
CONTROL BLDG.
STEAM GENERATOR BLDG.
TURBINE BLDG.
TURBINE BLDG.

- SHIELDED NHS ASSEMBLY MOVEABLE FOR SERVICE/REPLACEMENT
- MULTIPLE UNITS FOR INCREASED AVAILABILITY/REDUCED RESERVE MARGIN
- CAPACITY CAN GROW WITH DEMAND
- MINIMAL RELATION BETWEEN SITE CONSTRUCTION AND NUCLEAR HEAT SUPPLY UNITS

MODULAR BREEDER NUCLEAR HEAT SUPPLY (NHS)


CONTROL ROD DRIVES
AIR OUT
INTERMEDIATE COOLANT OUT
CONTAINMENT VESSEL
INTERMEDIATE COOLANT IN
IHX
PRIMARY VESSEL
BLANKET
CORE
EM PUMP
AIR IN

- NHS ASSEMBLY INCLUDING CONTAINMENT RAIL SHIPPABLE
- NATURAL CONVECTION OF AIR BETWEEN BIOLOGICAL SHIELD AND CONTAINMENT REMOVES SHUTDOWN HEAT
- STANDARD NHS SHOULD BE ACCEPTABLE FOR ALL SITES
- FACTORY PRODUCTION EXPECTED TO YIELD REDUCED COSTS WITH SUCCESSIVE ORDERS AND PRODUCTION EXPERIENCE

THE MODULAR BREEDER APPROACH

- FACTORY PRODUCTION/ASSEMBLY OF NHS
  - IMPROVED QC/QA WITH LOWER COSTS
  - REDUCED LABOR EFFORT WITH AUTOMATED PRODUCTION
  - EXPERIENCED MORE PRODUCTIVE LABOR FORCE
  - CONTINUED COST REDUCTION WITH PRODUCTION EXPERIENCE
  - SHIPMENT OF QUALITY ASSURED PRODUCT TO SITE
- MULTIPLE, REPLACEABLE, SHIPPABLE MODULES
  - CAPACITY ADDITION WITH DEMAND GROWTH
  - INCREASED AVAILABILITY WITH MULTIPLE MODULES
  - UNLIMITED SITE LIFE WITH REPLACEABILITY OF MODULES
  - REDUCED FINANCIAL RISK WITH SMALLER REACTORS
  - SHORTER CONSTRUCTION TIME WITH PARALLEL NHS/BOP CONSTRUCTION
- SHUTDOWN REACTOR COOLING WITHOUT PIPING OR SITE POWER
  - REDUCED FIELD QC/QA EFFORT
  - FIELD LABOR EFFORT CLOSER TO FOSSIL PLANTS
  - PIPING INTEGRITY NOT CRITICAL TO REACTOR PROTECTION
  - REDUCED PROTECTION OF AUXILIARIES AND LESS REDUNDANCY
  - INCREASED PUBLIC ACCEPTANCE WITH PROOF OF SAFETY

DEVELOPMENT AND PROOF OF STANDARD, SAFE, LOW COST NUCLEAR HEAT SUPPLY PROMISES SHORTER CONSTRUCTION TIMES, LOWER PLANT COSTS/RISKS AND CHEAPER ELECTRICITY

MODULAR BREEDER DEVELOPMENT

- DEVELOPMENT AND PROOF OF ONE MODULE PROVIDES BASIS FOR ANY FACILITY SIZE
- ONE TEST FACILITY PROVIDES SEQUENTIAL MODULE TESTS AND ADVANCEMENT TO STANDARD, ASSURED PRODUCT
- ADDITION OF MODULES TO ECONOMIC CAPACITY LEVEL PROVIDES PROMISE OF RECAPTURING DEVELOPMENT COSTS

MUTUALLY ACCEPTABLE FINANCIAL PLAN FOR DEMONSTRATION POSSIBLE AFTER INITIAL DESIGN & DEVELOPMENT OF KEY COMPONENTS

WHAT SHOULD BE DONE NOW?

- SEVERAL ADVANCED BREEDER CONCEPTS HAVE BEEN PROPOSED, BUT:
  - MODULAR BREEDER IS A NEW UNIQUE CONCEPT THAT ADDRESSES MOST OF THE PROBLEMS ASSOCIATED WITH NUCLEAR POWER
  - DESIGN AND ASSESSMENT EFFORT TO DATE LEAVES MANY QUESTIONS TO BE ANSWERED
  - ADDITIONAL WORK REQUIRED TO ADVANCE ASSESSMENT TO A LEVEL THAT PERMITS REASONABLE COMPARISON WITH OTHER MORE CONVENTIONAL APPROACHES

FY84 FUNDING LEVEL OF $5-6 MILLION NEEDED TO PROCEED WITH THIS ASSESSMENT

ELECTRIC POWER RESEARCH INSTITUTE

EPRI

April 15, 1983

Marilyn Lloyd Bouquard, Chairman
Subcommittee on Energy Research
and Production
U. S. House of Representatives
Suite 2321 Rayburn House Office Building
Washington, D. C. 20516

Dear Chairman Bouquard:

Attached are answers to the questions on the LMFBR posed in your letter of March 23, 1983. Thank you for the opportunity to comment.

Sincerely,

John Taylor

John J. Taylor, Director
for Nuclear Power

JJT:sb
Attachment

1. Is the DOE goal to terminate federally-supported R&D subsequent to the completion of the Large Scale Prototype Breeder plant realistic?

DOE's goal to terminate federally-supported R&D for the LMFBR at completion of the LSPB is achievable under the following conditions. First, it will be necessary to complete the construction and have logged substantial operating experience on the Clinch River Breeder Reactor plant. Second, it will be necessary that the Large Scale Prototype Breeder (LSPB) be designed such that a replicate of the LSPB could be built using conventional financing and result in a plant which would be economically competitive. However until breeders are deployed by the private sector in sufficient numbers such that the throughput would be large enough to permit the construction of commercial fabrication and reprocessing plants, the federal government should plan to continue to provide small and intermediate scale fuel fabrication and reprocessing facilities and services at a fair cost to the private sector.

The above could be significantly facilitated by a full scale international collaboration on the LMFBR program. The reason for this is threefold. First, a meaningful and equitable collaboration could result in reduced engineering costs in the U.S. for the LSPB and, therefore, cause the federal government's contribution to both first-of-a-kind engineering costs and R&D to be correspondingly reduced to a more acceptable level. Second, collaboration could also reduce the technical risk to the LSPB itself. Finally, utilities or the consortium financing a replicate plant will benefit from the construction and operating experience gathered not only from the LSPB but also from any plants built in collaboration so as to satisfy themselves that the technical risk of building a replicate is sufficiently manageable to justify the financial risk that such a venture entails.

We would also expect that after completion of the LSPB, a modest federal sustenance program in certain key technology areas would be desirable to encourage further augmentation of the technology. For example, it may be desirable to test advanced fuels in FFTF and in Clinch River at some point in time in order to achieve a sound concept which will deliver the higher breeding ratio necessary as increased numbers of LMFBRs go into operation. Modest sustenance programs are currently in place at DOE for light water reactors and we would expect that a similarly sized and funded program following initial operation of the LSPB would be helpful.

In summary, EPRI believes that this goal is achievable, assuming the program continues in the interim in a balanced way, and is adequately supported between now and the completion of the LSPB and expanded international LMFBR collaboration is established. If any of the above provisions fail to materialize (such as if CRBRP is cancelled), we would expect that the federally-supported R&D program will have to be increased and maintained after competion of the LSPB.

2. What impact, if any, does the breeder development program have on aiding the recovery of the nuclear industry to a healthy status?

The breeder development program is very strongly linked to the nuclear industry, both on the reactor manufacturers' and designers' side and the utility side of that industry At Westinghouse and General Electric, and, to a lesser extent, at B&W and Combustion Engineering, the breeder development groups were a direct spinoff from the light water reactor systems groups that preceded them. At Atomics International, the breeder connection goes all the way back to the early liquid metal experiments. Bechtel, Stone & Webster and Burns & Roe were all strongly involved in the design of Light Water Reactor (LWR) and HTGR plants before getting involved in the development of the commercial breeder. The largest utilities in the nation, in terms of installed nuclear capacity, are deeply involved in the breeder program. Commonwealth Edison and TVA are the prime movers on the CRBP program, and significant support is provided by the nuclear utilities in the country.

The three areas in which the LMFBR and LWR industries support and complement each other are the areas of long-term fuel supply, technology, and manpower. The following discussion will address these three areas.

FUEL SUPPLY

The support in the fuel supply area is the most obvious one. The prospect of being able to make use of the large amounts of depleted uranium already available in government storage would assume a long term, stable, and economic fuel supply for the nuclear industry. The closing of the fuel cycle, through the establishment of reprocessing plants and waste disposal systems, is, for the LMFBR industry a sine qua non, but it would also be a substantial benefit to the commercial nuclear industry once it is established. The large quantities of spent fuel presently occupying the cooling pools at reactor plants around the nation, would finally be able to be shipped away for reprocessing, providing plutonium and U_{235} for recycle into thermal reactors or for use in the breeder plants.

The availability of plutonium for recycle will put a ceiling on uranium prices and will provide confidence in the long-term viability of the nuclear option Even from the safeguards point-of-view, the best place for plutonium storage is within the core of the LMFBRs or within the plutonium recycle chain where in time the plutonium is destroyed in generating energy. The very existence of a closed fuel cycle in this country will provide us with a better opportunity to pursue nonproliferation policies around the world, by being able to promise fuel services to countries that would refrain from becoming weapons producing nations. This, in turn, would reestablish the U.S.'s role of leadership in international nuclear commerce and proliferation control.

TECHNOLOGY

Certain technological developments which were first brought about in the breeder program, through the use of funds available from government. utility and industry sources, have been subsequently used in the LWR industry. A few such developments are listed below.

In the area of reactor safety, source term experiments in the TREAT reactor help develop source terms for the LWR containment design. Alternate control rod drives developed for the LMFBR, provided ideas for improvements in the LWR control rod systems. Various developments in the man-machine interface first created for the LMFBR industry, are now being utilized in LWRs.

In the components area, various analytical codes, developed for the LMFBR program, are also now being used in design of LWR components. Fabrication methods developed for steam generators and IHXs in the LMFBR program, had spinoffs in improvements to the methods used for fabrication of LWR components.

Test facilities, originally established for the development of LMFBR technology, subsequently served successfully for testing required for resolution of urgent problems in the LWR industry. These included flow-induced vibrations tests, flow distribution tests, friction and wear tests. denting, and corrosion and plate-out tests. Fuel densification problems, first studied in the LMFBR field, were more easily resolved thanks to the availability of that knowhow to the LWR. LMFBR fuel failure test facilities such as the TREAT facility in Idaho are now being planned for use in LWR fuel failure experiments. Remote maintenance techniques, developed at places like HEDL, are used by the LWR industry. Nondestructive testing, mechanical properties testing, metallurgical laboratories and fabrication methods developed by the LMFBR base program, have all been successfully used in the LWR industry.

In the physics area, work on nuclear data base, reactor shielding materials and methods, are all successfully utilized in the LWR industry.

Seismic technology, developed for the more seismically vulnerable LMFBR, has provided significant help to the LWR industry when seismic requirements became predominant in that industry as well.

The above are a few of the technological developments first spawned in the LMFBR business, through the use of R&D funds, have found and continue to find successful utilization in the sister LWR industry.

MANPOWER
The breeder program is at the cutting edge of the nuclear technology and as such provides a challenging work environment for highly talented people in the industry. It provides an opportunity for people with advanced degrees in engineering and in the sciences to utilize their skills, thereby helping advance the state-of-the-art, with resulting spinoffs of technology usable in the nuclear industry as a whole. The ratio of engineers with advanced degrees is higher for the LMFBR programs than for the LWR programs. The reason for that is -- there is more need for developmental work, on a routine basis, in the LMFBR program. But, on the other hand, having this highly trained manpower available within the same companies, provides management with instant ability to respond to crisis situations, which are actually more likely to appear in an ongoing industry, such as the LWR, than in a developing industry. Eliminating this source of technical competence would not only hurt the development of the LMFBR but would also hurt the LWR industry. which continuously draws on the talents available in its sister industry.

To summarize, the breeder development program has a significant impact on the health of the nuclear industry, and the relatively small investment in this portion of the industry has a significant leverage on the industry as a whole.

3. Do you believe that the Administration's proposed FY1984 breeder reactor program is adequate? Please identify any areas of concern to you.

The program appears to be adequate, continued funding is provided for CRBRP. The continuation of CRBRP is our main area of concern and support for this project should receive the top priority. The impact of the projected budgets for fiscal years 1983 and 1984 cannot be readily determined and depends on a number of other factors that may offset the budget shortfall. These factors include:

(a) the level of fiscal year 1985 funding.

(b) increased private sector support from the industry to supplement Congressional appropriations.

(c) inflationary effects during the next several years.

It is important to again point out that international collaboration is a desirable incentive for obtaining private support for the U.S. program, and, since the -ain bargaining point in U.S. favor is the magnitude of the development program, any investment in it is likely to have beneficial results in this area. Conversely, failure to support CRBRP or further cuts in the base technology program may have detrimental effects on our efforts to establish expanded international agreements.

The base technology program, including operation of FFTF and the other unique test facilities in the U.S. LMFBR program, must be sustained at the level in the Administration's budget for at least the new few years. This is important to provide the basis for LSPB and its transition to the private sector and to develop the fuel cycle that will make the LMFBR viable for the utility industry.

4. Please discuss in general terms some ways to make the next breeder plant (beyond CRBR) commercially attractive (e g , standardization in design).

As indicated in my testimony, EPRI has recently established a program office in the Chicago area (the Consolidated Management Office or CoMO) which has been working on a joint government industry program to develop the next plant beyond Clinch River. Since we began operations at that office in October of last year. much of their activities have been focused on exactly the matter which you raise in this question. This activity is being conducted in a systematic manner wherein each reactor manufacture and architect-engineering organization has been assigned areas for in-depth review. Each organization is to identify all possible options which meet specific standards of safety and quality, and to select the option which results in lowest capital costs. Although there is much work to be done under this program and the answer to this question a year from now may be different from today. it appears that sufficient data have been collected to enable giving a credible response.

First, we have concluded that the next plant must be as close as possible to the "commercial LMFBR". of the early 21st centry. The reason for this relates to the cost required to engineer a LMFBR. The strategy which CoMO is currently following is to require that the design of the LSPB, if replicated and financed by a utility or a consortium of utilities. would be competitive with new coal-fired plants. The second element of the strategy is to require that the target plant, which is that plant presumed to follow the replicate, be competitive with all sources of base load generation, including coal and the light water reactor To achieve this, changes in the design will be present only to the extent that those changes can be quantified as to their impact on engineering costs and they require that the additional expense be cost effective. Currently, it appears possible to meet these objectives through various degrees of design simplification which are currently being evaluated.

Again, as I mentioned in answer to all three previous questions, we believe international LMFBR collaboration will assist in meeting our commercialization goals. This will allow the knowledge gained from a broad range of plant design approaches, and operational experience to be integrated into the Commercial Breeder Target Plant.

There are some features in the LMFBR which enhance its commercial attractiveness. First. as you know. a sodium cooled breeder presents a low corrosion environment to the systems which contain it. Experience with sodium cooled breeders in the past have indicated that they are more trouble free and may be less prone to corrosion induced failure than LWR plants. They, therefore, may be reasonably expected to operate with a higher availability which in turn improves the economics of the operation. In addition the fact that the coolant operates at a low pressure and a temperature substantially below its boiling point enables simplifications to be made in the design of these plants in comparison to current light water reactors. These simplifications ease the operation of the plants and also reduce the number of systems and components which require preventative and corrective maintenance. This also has a beneficial effect on plant availability and. therefore. combines to enhance the commercial attractiveness of the breeder.

The key apepars to be simplification combined with some modernization which takes optimum advantage of the inherent features of sodium cooled plants.

Natural Resources Defense Council, Inc.

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April 27, 1983

Ms. Julie Shisler
Staff Assistant
Subcommittee on Energy Research
and Production
B 374, Rayburn House Office Bldg.
Washington, D.C. 20515

Dear Ms. Shisler:

Please find enclosed a copy of my answers, on behalf of the Taxpayers Coalition Against Clinch River, to the additional questions posed by Chairman Bouquard in her letter of March 23, 1983.

Unfortunately, this letter was misaddressed and I received it only two weeks or so ago. Thus, I have been unable to meet the April 15th deadline set out there. I do hope that my response can still be made part of the record of your February 23rd hearing on the FY 1984 DOE budget request for the Breeder Reactor program.

Thank you.

Sincerely yours,

S. Jacob Scherr

S. Jacob Scherr

on behalf of the
Taxpayers Coalition Against
Clinch River

Enclosure

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100% Recycled Paper

Additional Questions To

S. JACOB SCHERR

Taxpayers Coalition Against Clinch River

Question

You stated in your testimony that CRBR is not an R&D project because it must undergo NRC licensing as a result of provisions of the Energy Reorganization Act, and since commercial plants must be licensed, CRBR is a commercial plant. The licensing criteria to be applied to the breeder are themselves R&D issues, because the CRBR is a first-of-a-kind demonstration of new technology. Are you saying that since commercial LWR plants must be licensed, all licensed plants by definition are commercial?

Response

Since its inception the Clinch River Breeder Reactor ("CRBR") has been designated as a commercial demonstration project, apart from the Federal Government's base breeder research and development program. The purpose of the CRBR is not to perform research on breeder technology, but rather remains "to demonstrate the technical performance, reliability, maintainability, safety, environmental acceptability, and economic feasibility of an LMFBR central station electric power plant in a utility environment." (*See* DOE, Final Environmental Impact Statement, Liquid Metal Fast Breeder Reactor Program (Supplement to ERDA-1535, Dec. 1975) at 57 (May 1982)).

One central element of commercial LMFBR demonstration has always been a showing that a breeder could be licensed just as any other utility nuclear power plant. Consistent with this objective, the Congress gave the Nuclear Regulatory Commission ("NRC") under the Energy Reorganization Act the authority to license "Demonstration Liquid Metal Fast Breeder reactors when operated as part of the power generation facilities of an electric utility system, or when operated in any other manner for the purpose of demonstrating the suitability for commercial application of such a reactor" (Public Law 93-438, Section 202). In contrast, the NRC does not license nor have any other regulatory authority over DOE's breeder research and development reactors, such as the EBR-II.

The CRBR is now undergoing the normal NRC licensing procedures because it is a commercial demonstration facility proposed to be operated within a utility environment. CRBR proponents have within the last few years begun to label the project as "R&D". This is not because the project or its purposes have changed, but rather because the prospects for breeder commercialization have faded so far into the future. There is a growing consensus that it makes no economic sense to build the CRBR now to demonstrate the commercial viability of a technology which will not be needed for forty or more years at the earliest.

Question

The following is a quotation from a recent syndicated column: "Irrespective of what happens in the US., however, the French are going to move ahead and will have an operational commercial breeder within two years, if all goes as planned. Clearly, the breeder is right for the French." Do you agree with this analysis? Please explain.

Response

While it is true that the French are moving forward with the construction of their large Super-Phenix breeder reactor, this does not mean that the prospects for commercial breeder deployment are any brighter in France. As pointed out in January 1981 by James L. Cochrane of the CIA, "the French breeder program faces strong economic problems that portend a bleak future for its survival, much less its expansion -- contrary to what is presented in the popular and trade press." The French Government has already deferred earlier plans to build follow-on plants to the Super Phenix, which cost substantially more than conventional light-water reactor (LWR) power plants. In addition, the French national electrical utility is facing major financial problems and has scaled back its projections for all future nuclear installations.

It must be remembered that the French pushed ahead as well with the development of the first supersonic commercial transport airplane, the Concorde. In the early 1970's, many of the same arguments made by CRBR proponents today were used in support of Federal Government subsidies for an American SST. The U.S. Congress refused to go along in spite of the cries that the U.S. would be abandoning aviation leadership to France. It is now clear that the Concorde is an economic disaster and it remains a substantial drain on French taxpayers.

Question

As you know, Japan has moved strongly into several industrial areas in recent years, providing stiff competition to American producers for such things as automobiles, computers and television sets. Now, there is growing evidence that Japan is about to move ahead of the United States in the export of breeder and other nuclear technology. (Refer to "Japan: The Nuclear Victor?," Forbes, December 6, 1982.) You favor cancelling the Clinch River Breeder; isn't this tantamount to abdicating the possibility of U.S. technology leadership and does this mean that you are willing to relinquish U.S. technological leadership in this area?

Response

I am intrigued by the suggestion that the Japanese are about to move ahead of the U.S. in the export of breeder technology when their own program is much smaller and less advanced than ours. Perhaps more importantly, it is difficult to envision who the customers will be for such exports. There is no market for breeders in the industrialized countries, and there will not be one for decades to come, or in the debt-ridden developing world, where ambitious plans, for example, in Mexico and Brazil, to build LWRs have been abandoned or scaled back in the face of economic realities. Cancelling the CRBR does not mean that the U.S. is abandoning "technological leadership", only that the U.S. is recognizing that there is no commercial need for this technology.

Question

Are you aware that there are significant data indicating that there is a correlation of almost one-to-one between growth in the gross national product and growth in the use of electrical energy? Do you have data to the contrary?

Response

The argument that GNP and electrical energy trends must continue in lockstep is an old myth. While there is a link between economic growth and electricity demand, there is tremendous flexibility in this linkage. (*See* Committee on Nuclear and Alternative Energy Systems, *Energy in Transition 1985-2010* (1981); Darmstadter, Dunkerly, and Alterman, "International Variations in Energy Use: Findings from a Comparative Study", 3 *Ann. Rev. Energy* 201-24 (1978); California Energy Commission, *Energy Tomorrow* (1980); and R. Stobough & D. Yergin, *Energy Future* (1979)). Both Japan and West Germany use half as much energy per unit of GNP than the U.S., while maintaining vigorous economic growth during much of the post-war period. In the United States, California in 1979 used 18% less energy than the national average, but has a 14% higher personal income.

There is also a danger in relying on historical trends as predictors of the future. Historic data also shows a near constant rate of auto accidents per unit of GNP, as well as correlations between the consumption of alcohol and tornadoes. Assertions that such trends must continue are unfounded.

Detailed analyses of the fast-growing Pacific Northwest show zero or even negative growth in energy use would achieve the same economic growth objectives at lower cost. (*See* R. Cavanagh *et al.*, *Choosing an Electrical Energy Future for the Pacific Northwest: An Alternative Scenario* (NRDC, 1980). Indeed, there is a risk that too much private capital will be diverted towards building power plants, which could be better utilized in more productive efficiency improvements and other investments.

Questions

How do you propose that our nation provide jobs for an ever-increasing population without the electrical energy necessary to fuel new factories and new industries?

Are you aware that experts in the electric utility industry are almost uniformally (sic) expressing grave concern about the supply of electricity by the next decade? Do you have any comment on those concerns?

Response

These questions divert attention from the real issue before this Subcommittee. Whether or not increased electrical energy generation is needed in the United States, it is clear that breeder reactors will play any significant role for at least the next forty years, if ever, in meeting that need.

Some utility executives indeed are very worried about the future of this generation of nuclear power plants. However, the CRBR will not help the nuclear industry out of its current doldrums and, according to some "pro-nuclear" commentators, may drag it down further.

Question

Are you aware of any domestically available source of energy comparable to that which could be produced by breeder reactors from fuel already mined and sitting on the surface of the earth in canisters at Oak Ridge, Tennessee?

Response

Yes, the sun and energy conservation both could contribute to inexhaustible domestic supplies of energy. The point is not whether a particular source of energy is available, but rather whether its utilization makes economic sense. Breeders simply cannot compete economically for the foreseeable future with LWRs, irregardless of whether the reactor's fuel is sitting above the ground or in a mine.

Question

Have you any data to indicate the relative environmental impact of producing energy through the use of those fuels already mined which can be employed in the breeder reactor as opposed to any other means of converting raw materials and fuels into electric energy?

Response

No. DOE's own FEIS Supplement on the LMFBR Program, noted above, fails to provide updated comparisons of the environmental impacts of breeders as opposed to LWRs, coal-fired or oil-fired power plants.

Question

Please comment on Dr. Weinberg's contention that the same economic criteria be applied to other inexhaustible energy sources (solar, fusion) as are being imposed upon the breeder and the Clinch River Project.

Response

I agree totally with Dr. Weinberg that the same economic criteria should be applied to other "inexhaustible" energy sources (solar, fusion) as are being applied to the CRBR. In fact, the CRBR remains a glaring example of inconsistency with this Administration's professed policy of limiting federal R&D funding to laboratory-scale demonstrations of technical feasibility. Applying the same criteria to all DOE energy R&D programs would result in only one conclusion -- the U.S. Government has no business in spending billions of taxpayers' dollars to subsidize the commercial demonstration of the breeder. (See also the recent report of the Energy Task Force of the President's Private Sector Survey on Cost Control).

Question

You propose that the termination of the CRBR will have no impact on this Nation's breeder development program. What alternative demonstration project do you propose to maintain a program focus? Please provide a detailed justification for the assertion of no program impact.

Response

I said that the cancellation of CRBR would have no impact on DOE's breeder base R&D program and that this program should be redesigned to reflect the lack of economic justification to move ahead with commercial demonstration of the breeder at this time. The base program could focus upon the operation of the FFTF to test advanced breeder fuels and components. The base program should have as a high priority the resolution of some of the key problem areas related to breeders, such as steam generators.

1984 DEPARTMENT OF ENERGY AUTHORIZATION

THURSDAY, FEBRUARY 24, 1983

House of Representatives,
Committee on Science and Technology,
Subcommittee on Energy Research and Production,
Washington, D.C.

The subcommittee met, pursuant to notice, at 9:30 a.m., in room 2325, Rayburn House Office Building, the Honorable Marilyn Lloyd Bouquard (chairman of the subcommittee) presiding.

Mrs. Bouquard. The subcommittee will come to order.

Without objection, our proceedings today may be covered and recorded by the media and other persons. Hearing none, so ordered.

Good morning, ladies and gentleman. Today we will be receiving testimony from the Department of Energy on the Government's civilian nuclear waste research and development program. This program is essentially divided into two main components. The first deals with generic research and development on nuclear waste disposal; and the second deals with repository specific research and development funded almost entirely by the private sector through the nuclear waste fund, recently created by the Nuclear Waste Policy Act of 1982.

Concerning the generic R&D program, the subcommittee is interested in identifying the geologic disposal activities referred to in the budget proposal and the rationale for including them under the federally funded, generic program, rather than under the commercially funded repository program.

The subcommittee, like the administration, is interested in maintaining the U.S. Government's participation in the international subseabed disposal program, but will study the DOE's proposals to insure that the United States is not in a lead role in these activities.

Concerning the repository specific research and development conducted under the nuclear waste fund, the subcommittee wishes to identify whether the work continues to be oriented toward research and development, and if so, to delineate when the gradual shift from research and development to commercial activities will result in a predominant focus of the program on these more routine commercial matters.

The subcommittee will probe the department on its plans for utilizing the authorized test and evaluation facility as a tool for developing confidence in the disposal technology. During the debate on the Waste Act, the subcommittee considered at great length whether the TEF should be colocated with a repository or separately sited. We originally decided that the most benefit would probably be derived from a TEF co-located with a repository. We are, however, concerned about the penalty to be paid in the TEF schedule because of the limitations in the act on when construction may begin. We are, therefore, curious as to which way the Department is leaning and would like to understand when decisions will be made relative to the TEF.

In a moment, as has been my practice as chairman, I will be turning the chair over to Congressman Lundine, who made significant contributions to the Congress in the consideration of the Waste Act.

Before I do, however, I would like to ask if the ranking Republican member of our subcommittee, the gentleman from Pennsylvania, Mr. Walker, would like to make any opening remarks at this point?

Mr. WALKER. Mr. Walker's statement will be inserted in the record at this point.

[The Walker statement follows:]

OPENING STATEMENT OF HON. ROBERT S. WALKER ON NUCLEAR WASTE MANAGEMENT PROGRAMS, FEBRUARY 24, 1983

Thank you, Madam Chairman, for this opportunity to welcome our witnesses today from the Department of Energy. Dr. Coffman will advise us on terminal waste disposition and remedial action. I understand that he will be able to tell us of significant progress accomplished during the past year.

On Tuesday, Assistant Secretary Brewer said that Mr. Robert Morgan has been appointed Director the Interim Nuclear Waste Policy Act Project Office. The formation of this office is in accordance with the Nuclear Waste Policy Act, legislation of which we are justifiably pleased. DOE's immediate response to the intent and contact of the act is gratifying.

We look forward to hearing from these witnesses. The interest which this committee has toward comprehensive nuclear waste and spent fuel management programs is evident by the efforts we have provided during the past several years. The West Valley project, commercial waste management, and associated activities, have been the objects of extended discussions and evaluations. We expect this hearing to be very helpful in bringing us up to date on program progress.

Again, Madam Chairman, thank you. I am certain we will all benefit from this testimony.

We are happy to have Dr. Brewer with us again this morning, accompanied by Dr. Coffman, and later Mr. Robert Morgan. You may proceed.

Dr. BREWER. Thank you.

Accompanying me today is Dr. Frank Coffman, Director of the office which deals with remedial action programs, TMI, West Valley, and programs not covered by the Nuclear Waste Policy Act.

I would like to offer for the record a rather lengthy statement, then talk for 5 or 10 minutes, and respond to questions.

Mrs. BOUQUARD. It will be included in the record. At this point I will turn the chair over to Mr. Lundine.

Mr. Lundine.

Mr. LUNDINE. I thank the chairman for the opportunity to chair this hearing.

I certainly have had a hand and a great deal of interest in the passage of the Nuclear Waste Policy Act. I, therefore, share the chairman's goal in assuring its proper implementation.

My particular interest is in seeing that the mission plan for the Secretary's activities under the act is properly prepared and sent to the committee in a timely manner. The mission plan, of course, will tell the Congress and the public just exactly what the Secretary must do to successfully build and operate a nuclear waste disposal repository. It will be the yardstick that we must use to measure the success or failure of the Secretary's waste disposal program.

We are pleased to have with us today, Dr. Shelby Brewer, the Assistant Secretary for Nuclear Energy in the Department of Energy, accompanied by Dr. Franklin E. Coffman, the Director of the Office of Terminal Waste Disposal and Remedial Action. Following them, will be Mr. Robert Morgan, the Director of the newly created Nuclear Waste Policy Act Project Office. All of our witnesses today are from the Department of Energy and we welcome them before us.

Dr. BREWER. As you know, one of the major events of the past session was the passage of the Nuclear Waste Policy Act of 1982. This act dealt with the principal operational elements of the back end of the fuel cycle, the civilian fuel cycle, interim storage, the possibility of a monitored retrieval capability, and ultimate disposition of high level waste in a geologic repository. Mr. Robert Morgan will be addressing the implementation of the Nuclear Waste Policy Act following my testimony.

In addition to the program provided for in the new legislation, there are a number of other civilian waste management operations and programs for which the Department is responsible. These programs deal with other classes of waste and are based on other legislation.

These other waste responsibilities have largely to do with past activities which are no longer active processes or active functions in the Department or in the private sector. Institutions have changed, environmental standards may have been enhanced, and the contamination must be fixed in order to conform to the new standards.

These are what we call remedial action programs. They have various legislative origins in the Department of Energy Act under various instruments of authority. These programs include: FUSRAP, the formerly utilized sites remedial action program authorized under the Atomic Energy Act of 1954; the uranium mill tailings remedial action program, authorized by Public Law 95-704; the Grand Junction program authorized under Public Law 92-314, and surplus DOE facilities under the Atomic Energy Act; our programs also include West Valley and TMI.

In the past, Mr. Chairman, these programs to clean up the Manhattan project wastes, mill tailings, and old civilian R&D program facilities have been managed on a level of effort basis. We took on new tasks as resources permitted. There was a built-in bow wave in the program as initial studies, NEPA requirements, and endless assessments of options consumed the fiscal resources of actually getting the job done.

I have insisted that the work projected with each item have a definable schedule, a beginning, a middle, and an end.

Dr. Coffman has brought a mission orientation to this diffused program in the past year, along with his other duties in managing the high level waste program now covered by the act. Uncertainties associated with EPA and NRC standards have been reduced; costs for completion have been cut almost in half. We are now within sight of asserting a definitive schedule for most of the remedial programs.

I would like to beg your indulgence for a few more minutes, Mr. Chairman, to allow Dr. Coffman to describe the principal elements of the remedial action program.

Dr. Coffman.

[The prepared statement of Mr. Brewer follows:]

STATEMENT OF SHELBY T. BREWER
ASSISTANT SECRETARY FOR NUCLEAR ENERGY
DEPARTMENT OF ENERGY
COMMITTEE ON SCIENCE AND TECHNOLOGY
SUBCOMMITTEE ON ENERGY RESEARCH AND PRODUCTION
U.S. HOUSE OF REPRESENTATIVES
FEBRUARY 24, 1983

REMEDIAL ACTION PROJECTS AND LOW LEVEL WASTE PROGRAMS

Madam Chairman,

My discussion today will be limited to those activities that are not covered under the functions assigned by the Nuclear Waste Policy Act of 1982. These include the Remedial Action Program, the West Valley Demonstration Project, Commercial Low-Level Waste, and Waste Treatment.

Remedial Action Program

The objective of the Remedial Action program is to treat or stabilize radioactive wastes and perform required decontamination and decommissioning at contaminated DOE and legislatively dictated non-government facilities and sites. The major program areas are: (1) Formerly Utilized Sites Remedial Action Program (FUSRAP); (2) remedial action at Grand Junction, Colorado (P.L. 92-314, as amended); (3) Uranium Mill Tailings Remedial Action Program (UMTRAP) for inactive uranium mill tailings sites (P.L. 95-604); and (4) management of certain radioactively contaminated Department facilities declared surplus and resulting principally from civilian nuclear energy programs.

The FY 1984 budget request for the Program is $93.98 million as compared to a FY 1983 appropriation of $63.39 million. This also includes funds for the West Valley demonstration of the solidification of high-level radioactive wastes for final disposal (P.L. 96-368).

Formerly Utilized Sites

The Formerly Utilized Site Remedial Action Program (FUSRAP) provides for remedial actions at former nuclear processing facilities, most privately owned, which became radioactively contaminated from Manhattan Engineer District or Atomic Energy Commission activities and which have not been decontaminated sufficiently to meet current health effects guidelines for unrestricted use. Potential health risks limit the utilization of these properties, and property values may in some cases be reduced. To remedy the situation, the contamination will be either stabilized in-place, with restrictions placed on site use, or the contamination will be removed and disposed of at another location. Thirty-five sites have been identified as potentially requiring remedial action. DOE has remedial action authority at 14 sites. Only minimal activity, limited to some preliminary engineering and environmental studies required for planning, will be carried out for non-authorized sites. At sites where remedial action is undertaken, stabilization in place will be the preferred option. Where removal of the contamination is necessary, DOE sites will be utilized for the disposal of small quantities of contaminated material. In other cases, the affected State would be expected to select a new disposal site to be owned by either the Federal or State government. The Oak Ridge Operations Office has the lead field office role in implementing this program.

In FY 1983, the remedial actions begun in FY 1982 at Bayo Canyon and on the upper part of Acid Pueblo Canyon, Los Alamos, New Mexico, have been completed. Remedial action to clean up the main drainage ditches from the Niagara Falls Storage Site (NFSS) in New York will be completed.

Design engineering will be initiated for remedial action at the Shpack, Massachusetts landfill; at Middlesex, New Jersey municipal landfill; and at Linde Air Products in Tonawanda, New York. Preliminary engineering will be completed for the remedial action at the DuPont Deepwater, New Jersey plant.

In FY 1984, design engineering and NEPA documentation will be completed at Linde Air Products in Tonawanda, New York; DuPont in Deepwater, New Jersey; and Middlesex Landfill and Middlesex Sampling Plant Phase III in Middlesex, New Jersey.

Grand Junction

Under Title II of Public Law 92-314, Congress authorized financial assistance to the State of Colorado, to limit radiation exposure resulting from the use of uranium mill tailings for construction purposes in Grand Junction, Colorado. This State/Federal cooperative effort with the State of Colorado is administered by the Colorado Department of Health through the Grand Junction Area Office. The remedial action provides for removal of uranium mill tailings from the premises of about 626 structures where radon daughter exposures exceed the Surgeon General's guidelines. Public Law 95-236 extended the time for property owners to apply for inclusion in the program and increased authorized program funding. Federal funds cover 75 percent of the program costs with the State providing the balance. FY 1985 is expected to be the last year Federal funds will be requested for the program. The Grand Junction Office administers this program. Through FY 1982, work had been undertaken at 472 structures including 400 residences, 12 schools, and 60 nonresidential structures. In FY 1983 the program will continue with radiological assessments and will initiate remedial actions at about 70 structures. In FY 1984, the program will complete remedial actions on 70 structures for a total of 612 structures out of a total of 626 to be completed.

Uranium Mill Tailings

The Uranium Mill Tailings Remedial Action (UMTRA) program is responsible for conducting remedial actions at 24 sites and an estimated 5,000-6,000 vicinity properties mandated by Public Law 95-604, "The Uranium Mill Tailings Radiation Control Act of 1978." Nine of the sites are designated as high priority, six as medium priority, and nine as low priority. The Act requires completion of the program within seven years of promulgation of standards by EPA, which were issued in December 1982. An evaluation is now ongoing to assess the feasibility and budget impact of the mandated 7-year schedule. After completion of the evaluation, an amendment to P.L. 95-604 may be offered to extend the period of DOE's authorization so the completion of the project can be accomplished in a more cost effective manner. Remedial actions will be conducted in accordance with cooperative agreements negotiated with the affected States and Indian tribes. Federal funds are to cover 90 percent of the remedial action costs (100 percent for those sites on Indian lands). The type of remedial action for the processing sites will be either to stabilize the mill tailings in-place, where feasible, or to remove the tailings to a new federally-owned disposal site. The program also includes the cleanup of properties in the vicinity of the processing sites which have become contaminated with radioactive material derived from the sites. It is estimated that from 5,000-6,000 vicinity properties--mainly in the Grand Junction area, but not authorized by the Grand Junction program--may be found eligible for cleanup. Engineering plans and environmental documents will be prepared for the cleanup and disposal operations at each site. The concurrences of the Nuclear Regulatory Commission (NRC) and the affected State (or Tribe) are required for each site remedial action plan.

Specific accomplishments planned for the balance of FY 1983 include the continuation of high priority remedial actions at vicinity properties near the Canonsburg, Salt Lake City, and Grand Junction sites and completion of detailed remedial action plans for four high priority sites (Canonsburg, Salt Lake City, Gunnison and Shiprock). In FY 1984, the program will complete NEPA work and initiate remedial action at these four high priority processing sites.

Surplus Facilities

This program provides for the safe management and disposition of the inventory of surplus Department-owned facilities that have been radioactively contaminated from civilian nuclear energy development programs. The decontaminated facilities and sites are returned to other productive use where appropriate. All defense-related DOE facilities are included in the Defense Nuclear Waste Management Budget. About 80 facilities are currently identified under this civilian activity. In addition, the program develops improved methods for decontamination and decommissioning which can be transferred to industry. A long range plan will be completed in FY 1984 to establish an overall schedule and priorities for sites currently in the surplus inventory. The Richland Operations Office has the lead field office role in implementing the program.

In FY 1983, the on-site activities at the Niagara Falls Storage Site will be accelerated with the goal of completing all interim work in early FY 1984. This will complete the impoundment of uranium residues and contaminated soils which are now in exposed or poor storage conditions in a new improved storage area, thereby assuring no further occurrence of off-site contamination and compliance with the State of New York requirements for radioactive effluent control. The engineering, design and planning phases of the Shippingport Decommissioning Project will be completed in FY 1983. The decommissioning operations at the Mound Facility, Ohio in the Plutonium Processing and Research Buildings will be continued, and the removal of the Waste Transfer System will be started. This work is being carried out as part of a joint project with Defense Programs, with total project completion planned for FY 1988 at a total cost of about $64 million. The project will be 50 percent completed at the end of FY 1983.

In FY 1984, interim actions at the high priority Niagara Falls Storage Site will be completed and substantial progress will be made at other high priority sites. The work at the Mound Facility will reach 60 percent completion. The remedial action program will assume responsibility for the Shippingport Atomic Power Station from DOE-Naval Reactors in late 1984 after defueling and shipment of the fuel to Idaho is completed. During the third quarter of FY 1984 a decommissioning contractor will be brought on board to participate with DOE-NR contractors in plant shutdown and maintenance. Preparations for start of the Decommissioning Project will be completed in FY 1985. Current projections are that D&D of the Shippingport plant will take approximately 3 1/2 years and cost approximately $67M.

Field work at the Weldon Spring, Missouri Site will include start of the stabilization test of pit No. 4; a draft environmental impact statement will be completed for the residue storage pits and the quarry; design engineering will be started for long-term actions at this site.

Radiological Survey and Certification Activities

To promote further efficiency, the Radiological Survey and Certification Activity responsibilities relating to the Remedial Action Program were transferred from the Office of the Assistant Secretary for Environment, Safety, and Emergency Preparedness to my office in January 1983. These activities, funded in FY 1983 at $3.7 million, will be absorbed in the Remedial Action Projects.

West Valley Demonstration Project

The objective of the West Valley Project is to demonstrate solidification for disposal of high-level nuclear wastes under the provisions of Public Law 96-368, the "West Valley Demonstration Project Act". The project will carry out integrated production-scale development and demonstration of the treatment of the high-level liquid nuclear wastes at the Western New York Nuclear Center.

Major activities to be performed as part of the project include: (1) necessary decontamination required to prepare existing facilities and equipment at the Center to accommodate the solidification project; (2) removal of the wastes from the underground storage tanks; (3) development, design, construction and operation of systems and necessary supporting facilities for the solidification of the wastes; (4) acquisition of containers for the permanent disposal of the solidified waste; (5) temporary storage and transportation of the solidified waste to an appropriate Federal repository for permanent disposal; (6) decontamination and decommissioning (D&D) of the waste tanks, facilities, hardware, and material used in carrying out the project; and (7) disposal of low-level and transuranic wastes produced from project activities.

The CY 1982 program emphasized site takeover and initiation of project activities. This year the development of definitive solidification and decontainment plans for carrying out the project is receiving priority attention. With the planning, scoping, characterization, and baselining efforts completed in FY 1983, the FY 1984 program will implement these plans with major emphasis in waste solidification development and design, and decontamination and decommissioning.

Our recent major accomplishments in CY 1982 included:

- Site takeover; issued final Environmental Impact Statement, and Record of Decision.
- Made first manned entry into hot cell.
- Inspected and sampled waste storage tanks.

The FY 1983 program includes the following critical activities:

- Complete waste process and form selection.
- Complete solidification conceptual design.
- Complete decontamination of crane room and work plans and procedures for next four hot cells.
- Commence construction of vitrification equipment component test stand.

In FY 1984 we plan to accomplish the following:

- Complete preliminary (Title I) design of high-level waste solidification equipment and facilities.
- Complete procurement of equipment items for waste solidification component test stand.
- Complete decontamination of four hot cells and work plans and procedures for five more hot cells.
- Initiate procurement of LLW/TRU sorting facility and LLW volume reduction equipment.

Low-Level Waste

Public Law 96-573, the Low-Level Radioactive Waste Policy Act, assigned States the responsibility for assuring disposal capacity for commercial low-level radioactive waste (LLW) generated within their borders. The formation of regional compacts to satisfy this responsibility was encouraged by the law. The law requires the Department to assist states in the development of an effective national LLW management system by 1986 and to evaluate this system in terms of operational efficiency by 1988.

During FY 1983, the Program will complete the development of the regional LLW data base, and continue State/regional technical and financial assistance in support of P.L. 96-573.

The LLW program in FY 1984 will primarily provide technical and financial assistance to States and regions to support selection and operation of new LLW disposal facilities by 1986 (primarily through regional compacts).

Waste Treatment

The objective of this program is to develop and demonstrate technologies for the treatment and immobilization of nuclear fuel cycle radioactive wastes in forms acceptable for transportation, storage and ultimate disposal. Specifically, high-level waste, transuranic waste, and sodium contaminated wastes are addressed. Over the years, methods for treating high-level and transuranic wastes have been developed. This program is now focused on determining the long-term reliability and maintainability of improved prototypical waste treatment systems, on testing and selecting acceptable waste forms for storage or permanent disposal in licensed facilities, and on demonstrating the adequacy of these technologies through their application to specific Departmental waste treatment efforts such as those at West Valley and Three Mile Island (TMI). Activities in this program are coordinated with other Departmental efforts related to fuel reprocessing, generation of special wastes, transportation, and terminal isolation of Department and commercial wastes.

In FY 1983, the performance requirements and specifications for high-level (main focus) and transuranic waste forms and their containers will be developed. The adequacy of a glass waste form to meet these performance requirements will be examined. A reference waste form for commercial high-level wastes will be selected. In the waste immobilization area, emphasis will be on the latest technology for waste vitrification, the liquid fed ceramic melter. Improvements will be made in performance of the melter feed, off-gas and waste glass canister treatment systems. Preparation for development and evaluation of a waste form alternative to glass will also be undertaken.

In FY 1984, waste solidification activities will focus on vitrification process controls and quality verification methods for demonstrating that the glass waste products meet the required specifications developed in FY 1983. Specifications for transuranic wastes will be completed in FY 1984, and development of transuranic waste treatment processes will continue in preparation for future demonstration of these techniques on actual wastes. The sodium treatment facility will be converted to handle radioactive materials and will process contaminated sodium from the Experimental Breeder Reactor-II (EBR-II) operations utilizing the system demonstrated in FY 1983. Criteria and guidance for shallow land burial of sodium contaminated wastes will be tested and completed.

U.S. Department of Energy
Assistant Secretary for
Congressional, Intergovernmental
and Public Affairs
Office of Public Affairs
Washington, D.C. 20585
202/252-5844

BIOGRAPHY

DR. SHELBY TEMPLETON BREWER

Dr. Shelby Templeton Brewer was nominated by the President on May 12, 1981, and confirmed by the Senate on June 19, 1981, as Assistant Secretary for Nuclear Energy, U.S. Department of Energy (DOE). In this capacity, he is responsible for all reactor development and demonstration programs, including the U.S. breeder and converter reactor programs; fuel cycle development for both breeder and converter systems; management of radioactive wastes and ultimate closure of the fuel cycle; production of enriched fuel for both domestic and foreign markets; naval reactor development and prototype operation; and unique applications of nuclear energy such as power isotopes and reactors for space missions. Prior to his current position, Dr. Brewer was Director, Office of Plans and Evaluation, Office of Nuclear Energy.

Before the creation of DOE in October 1977, Dr. Brewer served as Chief of Program Planning and Assessment for the Liquid Metal Fast Breeder Reactor Program in the former U.S. Energy Research and Development Administration. From 1971 to 1975, Dr. Brewer was manager of civilian nuclear power programs for the U.S. Atomic Energy Commission. He was a consulting engineer at Stone and Webster, responsible for reactor containment design, from 1968 through 1971.

From 1964 through 1968, Dr. Brewer held a number of positions on the staff at the Massachusetts Institute of Technology (MIT), including Director and Chief Project Engineer, Organic Reactor Project; and Research Associate, Fast Reactor Test Facility.

From 1960 to 1964, Dr. Brewer served as an officer in the U.S. Navy. Initially, he was in charge of a division aboard the aircraft carrier USS Randolph. From 1962 to 1964, he served as Director of the Departments of Nuclear Reactor Physics and Nuclear Reactor Engineering at the U.S. Naval Nuclear Power Staff in New London, Connecticut.

Dr. Brewer received a B.A. degree in humanities from Columbia University in 1959 and a B.S. degree in mechanical engineering from the same institution in 1960. He was awarded an M.S. degree and a Ph.D. degree in nuclear engineering from MIT in 1966 and 1970, respectively.

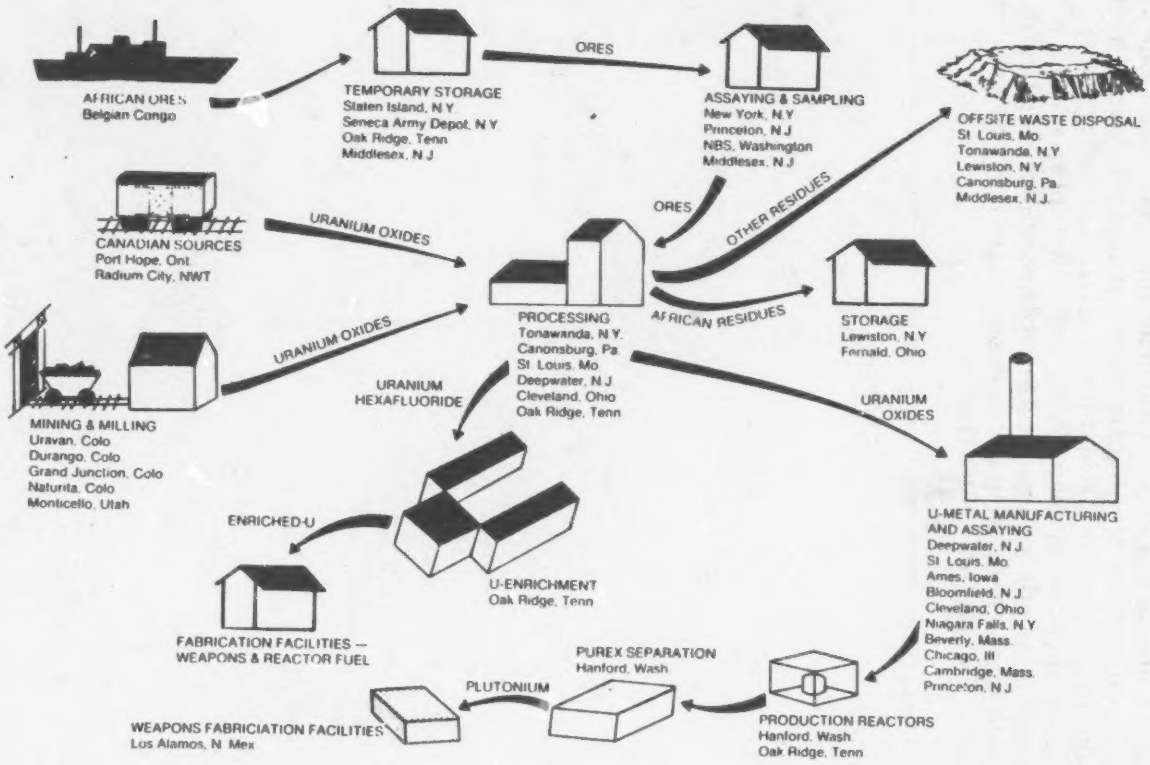
He is a member of the American Nuclear Society, Sigma Xi, and the American Association for the Advancement of Science. Dr. Brewer is the author of numerous papers and articles in the fields of fission reactor physics and engineering, strategic energy planning, and management control.

Born in Little Rock, Arkansas, Dr. Brewer currently resides in Gaithersburg, Maryland, with his wife, Marie, and their two children, Jens, 10, and Sara, 7.

Dr. **Coffman**. Thank you.

I think I will show just by a few examples the nature of the program and reserve the residual time for questions.

Paths for Uranium Material Production During the Manhattan Project



AFRICAN ORES
Belgian Congo

TEMPORARY STORAGE
Staten Island, N.Y.
Seneca Army Depot, N.Y.
Oak Ridge, Tenn
Middlesex, N.J

ASSAYING & SAMPLING
New York, N.Y
Princeton, N.J
NBS, Washington
Middlesex, N.J

OFFSITE WASTE DISPOSAL
St. Louis, Mo
Tonawanda, N.Y
Lewiston, N.Y
Canonsburg, Pa
Middlesex, N.J

CANADIAN SOURCES
Port Hope, Ont
Radium City, NWT

MINING & MILLING
Uravan, Colo
Durango, Colo
Grand Junction, Colo
Naturita, Colo
Monticello, Utah

PROCESSING
Tonawanda, N.Y.
Canonsburg, Pa
St. Louis, Mo
Deepwater, N.J
Cleveland, Ohio
Oak Ridge, Tenn

STORAGE
Lewiston, N.Y
Fernald, Ohio

U-METAL MANUFACTURING AND ASSAYING
Deepwater, N.J
St. Louis, Mo
Ames, Iowa
Bloomfield, N.J
Cleveland, Ohio
Niagara Falls, N.Y
Beverly, Mass.
Chicago, Ill
Cambridge, Mass.
Princeton, N.J

U-ENRICHMENT
Oak Ridge, Tenn

FABRICATION FACILITIES — WEAPONS & REACTOR FUEL

PRODUCTION REACTORS
Hanford, Wash.
Oak Ridge, Tenn

PUREX SEPARATION
Hanford, Wash

WEAPONS FABRICIATION FACILITIES
Los Alamos, N. Mex

ORES
URANIUM OXIDES
URANIUM OXIDES
ORES
OTHER RESIDUES
AFRICAN RESIDUES
URANIUM HEXAFLUORIDE
URANIUM OXIDES
ENRICHED-U
PLUTONIUM

Slide 1

GENRAP 01 009

Slide 1 shows the flow of nuclear material that came into this country during the Manhattan engineer district days. It resulted in storage facilities such as Middlesex, N.J., and assay and processing facilities, such as in New York and other places, and processing facilities and mill tailings scattered throughout the United States.

Those were thought to be disposed of properly at the time, with the safety standards of the time.

REMEDIAL ACTION PROGRAM
PROGRAM STRUCTURE

- FUSRAP — CARRY OUT CORRECTIVE ACTION AT 14 FORMER MED/AEC SITES; COMPLETE BY 1992.
- GRAND JUNCTION — CONDUCT REMEDIAL ACTIONS AT 630 STRUCTURES IN GRAND JUNCTION, COLORADO; COMPLETE BY 1986.
- UMTRAP — CONDUCT REMEDIAL ACTIONS AT 24 PROCESSING SITES AND AN ESTIMATED 5,000 VICINITY PROPERTIES; COMPLETE BY 1990.
- SURPLUS FACILITIES — PERFORM D&D OF APPROXIMATELY 80 SURPLUS CONTAMINATED DOE COMMERCIAL FACILITIES; COMPLETE BY 1994.
- RADIOLOGICAL SURVEY AND CERTIFICATION — DESIGNATE PROPERTIES FOR CLEANUP AND CERTIFY COMPLETION.

Slide 2 GENRAP 02 002

It has been determined these facilities need, in some cases, additional cleanup. They have been grouped into four basic categories—formerly utilized sites, sites for which the Atomic Energy Commission or its predecessor contracted with private industry.

We also have the inactive uranium mill tailings, 24 sites, by an act that transferred responsiblity to the Department of Energy to clean up those sites and their associated vicinity properties.

The Grand Junction Act, Public Law 92-314, required the Department on a 75-25-percent cost sharing with the States, to clean up some 740 residences, schools, and commercial properties in the Grand Junction area.

Last, there are the surplus DOE facilities. These are DOE-owned sites which are excess to mission needs, but for which some cleanup and restoration is required before they can be released for unrestricted use.

FY 1984 HS&T BRIEFING
REMEDIAL ACTION PROGRAM
BUDGET SUMMARY
(B/A/OBS. IN THOUSANDS)

Remedial Actions	FY 1982 Actuals	FY 1983 Continuing Resolution	FY 1984 Cong. Request
FUSRAP	$11,139	$11,700	$12,000
Grand Junction	1,672	1,672	1,500
UMTRAP	18,147	20,834	27,900
Surplus Facilities	11,933	12,933	15,500
Subtotal	42,891	47,139	56,900
West Valley	10,013	15,400	36,000
Program Direction	857	857	1,085
Total Decision Unit	$53,761	$63,396	$93,985
Radiological Survey and Certification	4,983 1/	3,700 2/	0 3/
Total Program	$58,744	$67,096	$93,985

1/ ASEP Funding. 2/ Funding Transferred to ASNE.
3/ THIS ACTIVITY IS TO BE COVERED BY THE FY 1983 REMEDIAL ACTION PROGRAM BUDGET.

Slide 3 this shows the budget for those separate categories. As you can see, the formerly utilized site remedial action program is a level of effort program at about $12 million per year in 1984 dollars. The Grand Junction program is a program that has run at less than $2 million per year; approximately $17 million has been expended. The total project cost is about $23 million.

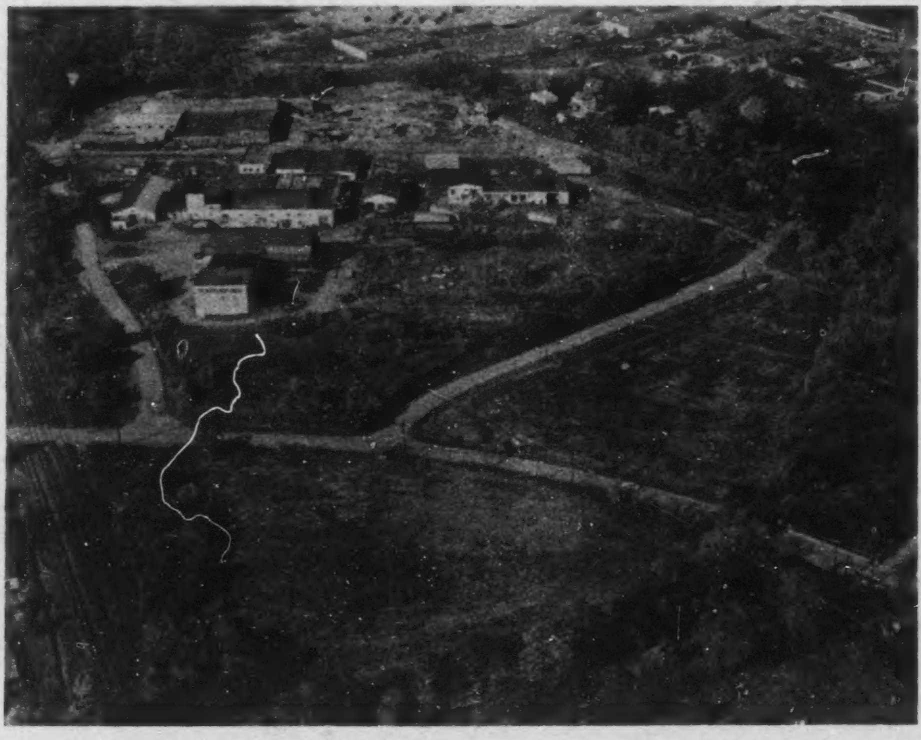
The uranium mill tailings program was, under the act, a 7-year program with the clock starting to tick from the date of enactment of EPA standards. The EPA issued final standards for the inactive sites in January 1983. That program has grown as it moves into physical cleanup of sites, such as Canonsburg and Salt Lake City.

Surplus facilities simply is a level of effort program, wherein the Department attempts to clean up surplus facilities located throughout the United States for unrestricted use, where possible.

Last, the West Valley project is a waste solidification demonstration program introduced under the West Valley Demonstration Project Act. As you well know, Mr. Chairman, the Department of Energy took possession of that last February and we have been proceeding with conceptual design and actual cleanup of the facilities.

We have a radiological survey and certification function which has been grouped into a singular management structure during the last few months.

I have a few graphs that will give you examples of sites, and then I will be open for questions.



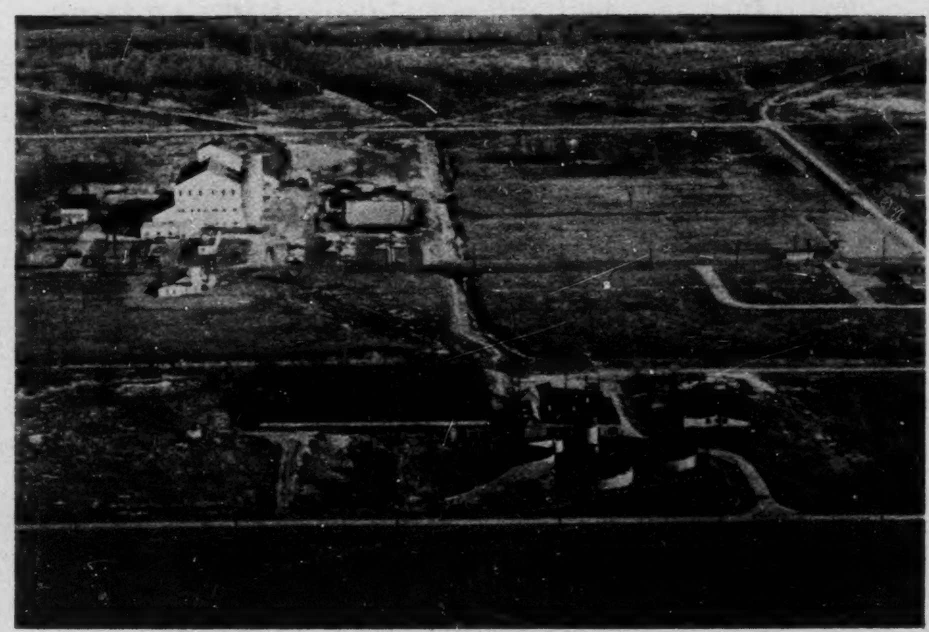
Slide 4

Slide 4 is the Canonsburg site, one of the 24 UMTRAP facilities. All of the vicinity properties will be cleaned up this year. If we are successful with our State negotiation, we will begin physical cleanup. The lower half are fields of tailing piles, the old building site is in the upper half of the picture.

This is the facility that provided the major portion of Madame Curie's uranium in the twenties and thirties.

Slide 5

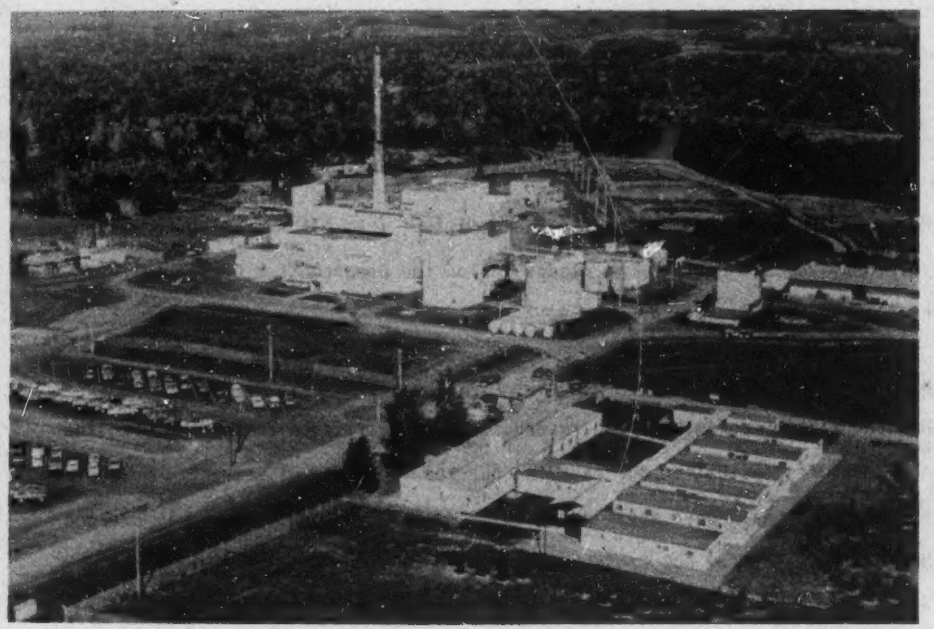
Slide 5 is a fire station in Salt Lake City, a place where the mill tailing piles were used as fill and resulted in abnormal radon levels inside the building.



Slide 6

Slide 6 is an example of the Niagara Falls storage site in New York. It stores United States ores and also has some AFRIMAT ores. It was also used for boron separation during the mid-AFRIMAT days.

This is the West Valley site. This is a fairly recent picture, showing some of the restoration work that has gone on during the last 9 months. You have the lagoons in the upper part of the picture, the administrative buildings in the lower half, the main reprocessing plant in the center, and the tank farm on the extreme left.



Slide 7

Slide 7 During the last year we have been actively pursuing the conceptual planning and design aimed at developing a schedule and total estimated cost for the initial phase. That work will be completed at the end of fiscal 1983. This year we have begun cleaning up contaminated areas such as the manipulator maintenance shop and hot cell facilities.

These are examples of the kind of work that goes on in this program. We would be happy to take questions. We also have a 3½-minute film on West Valley if you would like to see it.

[The prepared statement of Mr. Coffman follows:]

Statement of Franklin E. Coffman
Acting Director, Office of Terminal Waste Disposal and Remedial Action
Department of Energy
Before the Subcommittee on Energy
Research & Production
House Committee on Science & Technology
February 24, 1983

Madam Chairman and Members of the Subcommittee, I am pleased to appear before you today to take part in the discussion on the Department's Commercial Nuclear Waste Management Programs.

With the passage of the Nuclear Waste Policy Act of 1982, the DOE's Commercial Nuclear Waste Program has been restructured to facilitate compliance with that Act. The responsibility for carrying out the functions of Secretary Hodel under the Act have been assigned to the Project Director of the newly created Nuclear Waste Policy Act Project Office. That Office will be operational until the mandated Office of Civilian Waste Management is activated. I am accompanied here today by the Director of the Project Office, Mr. Robert L. Morgan, who has programmatic responsibility for the above mentioned functions and will be testifying on the activities to be conducted under the Act.

Those Commercial Waste management programs--Remedial Action Program (RAP), West Valley Demonstration Project (WV), Commercial Low-Level Waste and Waste Treatment--which do not fall within the purview of the Act remain my programmatic responsibility and it is these programs that I shall now consider. I shall also dissuss the Three Mile Island Program which is funded under the Converter Reactor Program but managed under the Commercial Nuclear Waste Management Program.

REMEDIAL ACTION PROGRAM

The objective of the Remedial Actions program is to treat or stabilize radioactive wastes and perform required decontamination and decommissioning at contaminated DOE and legislatively dictated non-government facilities and sites. The major program areas are: (1) formerly utilized sites remedial action program (FUSRAP); (2) remedial action at Grand Junction, Colorado (P.L. 92-314, as amended); (3) uranium mill tailings remedial action program (UMTRAP) for inactive uranium mill tailings sites (P.L. 95-604); (4) management of certain radioactively contaminated Department facilities declared surplus and resulting principally from civilian nuclear energy programs; and (5) demonstration of the solidification of high-level radioactive wastes at West Valley for final disposal (P.L. 96-368).

The FY 1984 budget request for the Program is $93.98 million as compared to an FY 1983 appropriation of $63.39 million.

Formerly Utilized Sites

The formerly utilized site remedial action program (FUSRAP) provides for remedial actions at former nuclear processing facilities, some privately owned, which became radioactively contaminated from Manhattan Engineer District or Atomic Energy Commission activities and which have not been decontaminated sufficiently to meet current health effects guidelines for unrestricted use. Because of the potential health risks, personal utilization is limited and property values are in some cases greatly reduced. To remedy the situation the contamination will be either stabilized in-place, with restrictions placed on site use or the contamination will be removed and disposed of at another location. Thirty-five sites have been identified as potentially required remedial action. Legislative authority for DOE action exists for 14 sites, and remedial actions can only be undertaken at those sites. Only minimal activity, limited to some preliminary engineering and environmental studies required for planning, will be carried out for non-authorized sites. Disposal sites for removed materials, if required, will be arranged with Federal, State and local authorities. The Oak Ridge Operations Office has the lead field office role in implementing this program.

In FY 1983, the remedial actions at Bayo Canyon and on the upper part of Acid Pueblo Canyon, Los Alamos, New Mexico begun in FY 1982 will be completed. A major effort will be accelerated to complete remedial action on properties in the vicinity of the Niagara Falls Storage Site (NFSS) in New York to complete cleanup of all offsite comtamination.

Design engineering will be initiated for remedial action at the Shpack, Massachusetts landfill, Middlesex, New Jersey municipal landfill and for the remedial action at Linde Air Products in Tonawanda, New York; preliminary engineering will be completed for the remedial action at the DuPont Deepwater, New Jersey plant.

In FY 1984, design engineering and NEPA documentation will be completed at Linde Air Products in Tonawanda, New York; DuPont in Deepwater, New Jersey; and Middlesex Landfill and Middlesex Sampling Plant Phase III in Middlesex, New Jersey.

Grand Junction

Under Title II of Public Law 92-314, Congress authorized financial assistance to the State of Colorado, to limit radiation exposure resulting from the use of uranium mill tailings for construction purposes in Grand Junction, Colorado. This State/Federal cooperative effort with the State of Colorado is administered by the Colorado Department of Health through the Grand Junction Area Office. The remedial action provides for removal of uranium mill tailings from the premises of about 626 structures where radon daughter exposures exceed the Surgeon General's guidelines. Public Law 95-236 extended the time for property owners to apply for inclusion in the program which has now expired, and increased authorized program funding. Federal funds cover 75 percent of the program costs with the State providing the balance. FY 1985 is expected to be the last year Federal funds will be requested for the program. The Grand Junction Office administers this program. Through FY 1982, work had been undertaken at 472 structures including 400 residences, 12 schools, and 60 nonresidential structures. In FY 1983 the program will continue with radiological assessments and will initiate remedial actions at about 70 structures. In FY 1984, the program will complete remedial actions on 70 structures for a total of 612 structures out of a total of 626 to be completed.

Uranium Mill Tailings

The uranium mill tailings remedial action (UMTRA) program is responsible for conducting remedial actions at 24 former processing sites and an estimated 3,000-5,000 vicinity properties mandated by Public Law 95-604, "The Uranium Mill Tailings Radiation Control Act of 1978." Nine of the sites are designated as high priority, six as medium priority, and nine as low priority. The act requires completion of the program within seven years of promulgation of standards by EPA, which were issued in December 1982. An evaluation is now ongoing to assess the feasibility and budget impact of the mandated 7-year schedule. After completion of the evaluation, an amendment to P.L. 95-604 may be offered to extend the period of DOE's authorization so the completion of the project can be accomplished in a more cost effective manner. Remedial actions will be conducted in accordance with cooperative agreements negotiated with the affected States and Indian tribes. Federal funds are to cover 90 percent of the remedial action costs (100 percent for those sites on Indian lands). The type of remedial action for the processing sites will be either to stabilize the mill tailings in-place, where feasible, or to remove the tailings to a new federally-owned disposal site. The program also includes the cleanup of properties in the vicinity of the processing sites which have become contaminated with radioactive material derived from the sites. It is estimated that from 5,000-6,000 vicinity properties, mainly in the Grand Junction area, but not covered by the Grand Junction program may be found eligible for cleanup. Engineering plans and environmental documents will be prepared for the cleanup and disposal operations at each site. The concurrences of the Nuclear Regulatory Commission (NRC) and the affected State (or Tribe) are required for each site remedial action plan.

Specific accomplishments planned for the balance of FY 1983 include the continuation of high priority remedial actions at vicinity properties near the Canonsburg, Salt Lake City, and Grand Junction sites and completion of detailed remedial action plans for four high priority sites (Canonsburg, Salt

Lake City, Gunnison and Shiprock). In FY 1984, the program will initiate remedial action work at these four high priority processing sites and complete NEPA work for all sites.

Surplus Facilities

This program provides for the safe management and disposition of the inventory of surplus radioactively contaminated Department-owned facilities from civilian nuclear energy development programs. The decontaminated facilities and sites are returned to other productive use where appropriate. All defense-related facilities are included in the Defense Nuclear Waste Management Budget. About 80 facilities are currently identified under this civilian activity. In addition, the program develops improved methods for decontamination and decommissioning which can be transferred to industry. A long range plan will be completed in FY 1984 to establish an overall schedule and priorities for sites currently in the surplus inventory. The plan will provide for completion of decommissioning of the current inventory by 1994, and work scheduled using a methodology for analysis of priorities. The Richland Operations Office has the lead field office role in implementing the program.

In FY 1983, the on-site activities at the Niagara Falls Storage Site will be accelerated with the goal of completing all interim work in early FY 1984. This will complete the impoundment of uranium residues and contaminated soils which are now in exposed or poor storage conditions in a new improved storage area, thereby assuring no further off-site contamination occurs and compliance with the State of New York requirements for radioactive effluent control. The engineering, design and planning phases of the Shippingport Decommissioning

Project will be completed in FY 1983. The decommissioning operations at the Mound Facility, Ohio in the Plutonium Processing and Research Buildings will be continued, and the removal of the Waste Transfer System will be started. This work is being carried out as part of a joint project with Defense Programs, with total project completion planned for FY 1988 at a total cost of about $64 million. The project will be 50 percent completed at the end of FY 1983.

In FY 1984, interim actions at the high priority Niagara Falls Storage Site will be completed and substantial progress will be made at other high priority sites. The work at the Mound Facility will be continued and reach 60 percent completion. The remedial action program will assume responsibility for the Shippingport Atomic Power Station from DOE-Naval Reactors in late 1984 after defueling and shipment of the fuel to Idaho is completed. During the third quarter of FY 1984 a decommissioning contractor will be brought on board to participate with DOE-NR contractors in plant shutdown and maintenance and will complete preparations for start of the Decommissioning Project in FY 1985. Current projections are that D&D of the Shippingport plant will take approximately 3 1/2 years and cost approximately $67M.

Field work at the Weldon Spring, Missouri Site will include start of the stabilization test of pit No. 4; a draft environmental impact statement will be completed for the residue storage pits and the quarry; design engineering will be started for long-term actions at this site.

Radiological Survey and Certification Activities

To promote further efficiency, the Radiological Survey and Certification Activity responsibilities relating to the Remedial Action Program were transferred from the Office of the Assistant Secretary for Environment, Safety, and Emergency Preparedness to my office in January 1983. These activities, funded in FY 1983 at $3.7 million, will be absorbed in the Remedial Action Projects.

West Valley

The objective of the West Valley Demonstration Project is to dmonstrate solidification for disposal of high-level nuclear wastes under the provisions of Public Law 96-368, the "West Valley Demonstration Project Act". The project will carry out an integrated production-scale development and demonstration project for treating the high-level liquid nuclear wastes at the Western New York Nuclear Service Center, near West Valley.

Major activities to be performed as part of the project include: (1) necessary decontamination required to prepare existing facilities and equipment at the Center to accommodate the solidification project; (2) removal of the wastes from the underground storage tanks; (3) development, design, construction and operation of systems and necessary supporting facilities for the solidification of the wastes; (4) acquisition of containers for the permanent disposal of the solidified waste; (5) temporary storage and transportation of the solidified waste to an appropriate Federal repository for permanent disposal; (6) decontamination and decommissioning (D&D) of the waste tanks, facilities, hardware, and material used in carrying out the project; and (7) disposal of low-level and transuranic wastes produced from project activities.

The CY 1982 program emphasized site takeover and initiation of project activities. This year the development of definitive solidification and decontainment plans for carrying out the project is receiving priority attention. With the planning, scoping, characterization, and baselining efforts completed in FY 1983, the FY 1984 program will implement these plans with major emphasis in waste solidification development and design, and decontamination and decommissioning.

Since taking over the site in 1982 our recent major accomplishments included:

- Issued waste solidification final EIS and Record of Decision.
- Made first manned entry into hot cell; inspected and sampled waste storage tanks.

The FY 1983 program includes the following critical activities:

- Complete waste process and form selection; and complete solidification conceptual design.
- Complete decontamination of crane room and work plans and procedures for next four hot cells.
- Commence construction of vitrification equipment component test stand.

In FY 1984 we plan to accomplish the following:

- Complete preliminary (Title I) design of high-level waste solidification equipment and facilities.
- Complete procurement of equipment items for waste solidification component test stand.

- Complete procurement of equipment items for waste solidification component test stand.
- Complete decontamination of four hot cells and work plans and procedures for five more hot cells.
- Initiate procurement of LLW/TRU sorting facility and LLW volume reduction equipment.

Low-Level Waste

Public Law 96-573, the Low-Level Radioactive Waste Policy Act, assigned States the responsibility for assuring disposal capacity for commercial low-level radioactive waste (LLW) generated within their borders. The formation of regional compacts to satisfy this responsibility was encouraged by the law. The goal of the Department's LLW program is to assist states in the development of an effective national LLW management system by 1986 and to evaluate this system in terms of operational efficiency by 1988.

During FY 1983, the Program will complete the development of the regional LLW data base, and continue State/regional technical and financial assistance in support of P.L. 96-573.

The LLW program in FY 1984, will primarily provide technical and financial assistance to States and regions to support selection and operation of new LLW disposal facilities by 1986 (primarily through regional compacts).

Waste Treatment

The objective of this program is to develop and demonstrate technologies for the treatment and immobilization of nuclear fuel cycle radioactive wastes in

- Complete procurement of equipment items for waste solidification component test stand.
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- Initiate procurement of LLW/TRU sorting facility and LLW volume reduction equipment.

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Waste Treatment

The objective of this program is to develop and demonstrate technologies for the treatment and immobilization of nuclear fuel cycle radioactive wastes in forms acceptable for transportation, storage and ultimate disposal in a licensed repository. Specifically, high-level waste, transuranic waste, and sodium contaminated wastes are addressed. Over the years, methods for treating high-level and transuranic wastes have been developed. This program is now focused on determining the long-term reliability and maintainability of improved prototypical waste treatment systems, to test and select acceptable waste forms for storage or permanent disposal in licensed facilities, and to demonstrate the adequacy of these technologies through their application to specific Departmental waste treatment efforts such as those at West Valley and Three Mile Island (TMI). Activities in this program are coordinated with other Departmental efforts related to fuel reprocessing, generation of special wastes, transportation, and terminal isolation of Department and commercial wastes.

In FY 1983, the performance requirements and specifications for high-level (main focus) and transuranic waste forms and their containers will be developed. The adequacy of a glass waste form to meet these performance requirements will be examined. A reference waste form for commercial high-level wastes will be selected. In the waste immobilization area, emphasis will be on the latest technology for waste vitrification, the liquid fed ceramic melter. Improvements will be made in performance of the melter feed, off-gas and waste glass canister treatment systems. Preparation for furthering development and evaluation of a waste form alternative to glass will also be undertaken.

In FY 1984, waste solidification activities will focus on vitrification process controls and quality verification methods for demonstrating that the glass waste products meet the required specifications developed in FY 1983. Specifications for transuranic wastes will be completed in FY 1984 and transuranic waste treatment processes development will continue in preparation for future demonstration of these techniques on actual wastes. The sodium treatment facility will be converted to handle radioactive materials and will process contaminated sodium from the Experimental Breeder Reactor-II (EBR-II) operations utilizing the system demonstrated in FY 1983. Criteria and guidance for shallow land burial of sodium contaminated wastes will be tested and completed.

THREE MILE ISLAND PROGRAM

The Three Mile Island Activities program is funded under the Converter Reactors program but is managed and will be discussed under the Commercial Waste Management program. The objectives of this program are to acquire information and conduct R&D that will substantially enhance nuclear powerplant safety, reliability, and operation; and ensure the means to safely dispose of abnormal nuclear wastes resulting from an accident.

In consonance with the Administration's policy of retaining responsibility for commercial nuclear power activities in the private sector, the Department's TMI program is limited to research and development which will be of overall value to the development and safety of nuclear power and waste management. Responsibility for the costs of TMI cleanup remain with General Public Utilities (GPU), the owner of the facility.

The TMI activities are being implemented in accordance with a memorandum of understanding by DOE, NRC, EPRI, and GPU. The efforts of GPU are aimed at plant cleanup and recovery. The Department has developed a program work scope that enables obtaining important R&D information that would not otherwise be available from the TMI-2 cleanup effort. The DOE program is being conducted in a manner that avoids delaying the GPU cleanup schedule.

In accordance with a Memoranum of Understanding Between the DOE and the Nuclear Regulatory Commission, the Department will acquire unique radioactive waste, including the damaged core, from TMI for research and development, and for disposal.

Two subprograms compose the TMI program: TMI Data Acquisition Program and TMI Waste Immobilization and Reactor Evaluation Program. The FY 84 Budget Request for this program is $37.0M as compared to $29.0M in FY 83.

TMI Data Acquisition Program

The objective of this subprogram is to obtain R&D data of generic value to the safety of light water reactors.

The DOE and Electric Power Research Institute (EPRI) are sharing responsibility and costs for portions of this R&D program. Specifically, the Department is funding data gathering, research and development, and information transfer in the following major areas: instrumentation and electrical equipment survivability; behavior of radioactive products; data system and specimen schieving; and offsite fuel debris examination. EPRI has responsibility for mechanical and structural component reliability, pressure boundary recharacterization, and decontamination and dose reduction associated with the primary coolant system.

During FY 1983, the analysis of the hydrogen burn event in the TMI-2 containment will be completed and the results provided to NRC and Industry for use in calibrating their analytical techniques. Technology transfer activities in the instrumentation programs will be emphasized. Techniques to develop techniques to re-qualify electrical cables in-situ will be developed.

In FY 1984, DOE plans to conduct the in-situ and offsite examination of selected instrumentation and electrical components to ascertain their condition, cause of failure, and features which affect equipment survivability. Data obtained will be used to upgrade standards and guides, resulting in improved equipment for surveillance of nuclear plants. Efforts will continue on analyzing samples to identify how various radioactive isotopes, released within the containment building during the accident, were transported and deposited. These data will be valuable in assessing the existing models for fission product release which are used in nuclear powerplant licensing. Preparation for the offsite examination of fuel debris will be continued but actual examination will not begin until after defueling in 1984 and 1985. The computer data bank system will continue to collect, store and transfer to NRC and industry the data and documentation generated by the Department's program.

TMI Waste Immobilization and Reactor Evaluation

The objectives of this subprogram are: (1) to conduct research and development on immobilization of abnormal reactor waste products, and (2) to examine the TMI-2 reactor and core components in-situ and to support development activities associated with the reactor defueling; the data and information acquired will provide an improved basis for evaluation of licensing criteria and requirements, analyzing causes and consequences of accidents, and improving the reliability of the design and operation of LWR's. This program element was initiated in FY 1982.

The waste management and immobilization activities are initially being focused on an effort to demonstrate the feasibility of vitrifying zeolite ion exchange materials. The program will have demonstrated this feasibility in FY 1982 and FY 1983.

Beginning in FY 1983 and continuing in FY 1984, this subprogram is focusing on other techniques for the treatment of abnormal wastes produced at TMI, including alternative immobilization concepts for inorganic ion exchange zeolites and organic resins, confidence testing and long term sample observation to provide a more extensive data base. Some of the areas which will be addressed by the program include demonstration of liner disposal in a high integrity container, resin solidification and lysimeter testing. The knowledge gained from this program will contribute substantially to the technology for processing and disposing of unique waste forms resulting from abnormal reactor operations and accidents.

The reactor evaluation activities include development associated with the examination, removal, and disposition of the reactor core and internals, and the special systems, equipment, facilities, and processes needed to accomplish the defueling operation and supporting onsite examinations, tests, and evaluations of this fuel effectively and expeditiously.

Principal efforts will be directed to the goal of removing the reactor head late in FY 1983. In parallel, the development and engineering of systems, equipment and procedures for reactor plenum removal and storage, and for reactor defueling and fuel transfer will be initiated. In FY 1984, plenum removal will be accomplished and core disassembly activities will begin. The development work will be directed toward preparing for a thorough examination of the reactor internals and core, and performance of the defueling effectively and in a radiation environment as low as practicable. Substantial beneficial information and data on the condition of the reactor, core and other internal components will be obtained. In addition, preparations will be made to perform extensive off-site examinations of the fuel and debris and other reactor internal components to characterize the accident effects.

The knowledge gained from this program will provide data required for evaluating present licensing criteria and requirements; developing future licensing criteria; assessing and developing computer models used to analyze the course and consequences of severe accidents and means to mitigate the effects of such accidents; and evaluating improvements to reactor design, operation, and maintenance.

This completes my testimony Madam Chairman. I shall be pleased to answer any questions that you and your subcommittee may have at this time.

FRANKLIN E. COFFMAN

Dr. Franklin E. Coffman is the Director of the Office of Terminal Waste Disposal and Remedial Action, Office of Nuclear Energy, U.S. Department of Energy. In this position, which he assumed in December 1981, he is responsible for the Department's commercial waste management programs and projects. This includes the development of repositories for the disposal of radioactive waste, remedial actions at Federal and private sites, activities associated with the cleanup, treatment and disposal of wastes from Three Mile Island, and research, development and demonstration of waste treatment processes including the solidification of wastes at West Valley, New York.

Prior to his current assignment, Dr. Coffman was also responsible for DOE Utility Coordination activities, managing programs relating to development and delivery of nuclear power systems for space and terrestrial applications, the gas-cooled reactor program, advanced isotope separation technology, and evaluation of advanced nuclear energy system concepts. From July 1978 through September 1980 Dr. Coffman served as Director of the Division of Development and Technology in the Department of Energy's Office of Fusion Energy. These responsibilities included systems engineering, facility component development, and development of base technology for fusion energy commercialization.

Dr. Coffman joined the Atomic Energy Commission in 1970. He has served as an environmental scientist and health physicist working the areas of tritium handling, reactor safety research, environmental statements, site decontamination, AEC facility accident investigations, and pollution control.

Born in Livermore, Kentucky, in 1942, Dr. Coffman received a BS degree in Mathematics and Physics, cum laude, from Western Kentucky State University, a MA in Plasma Physics, and a PhD in Nuclear Physics from Vanderbilt University, cum laude.

He has received numerous awards during his career with the Federal Government. He has also published and presented numerous technical and policy papers and served as a peer reviewer of scientific journals.

Dr. Coffman and his wife, Elaine, from Bardstown, Kentucky, reside with their son in Gaithersburg, Maryland.

Nuclear Waste Policy Act of 1982

Objectives: Construct repositories for permanent disposal of nuclear waste by 1998; propose for construction of one or more monitored retrievable storage facilities by 1985; assist utilities in development and licensing of additional at-reactor storage capacity and provide necessary emergency Federal interim storage.

GEOLOGIC REPOSITORY

NWPA: Issue general siting guidelines within 180 days; identify states with potential sites and notify States by April 1983; hold public hearings in States with potential sites prior to Nomination; nominate five sites; recommend three sites to the President by January 1985.

TEST AND EVALUATION FACILITY

NWPA: Submit report on whether or not to colocate TEF and repository by January 1984.

MONITORED RETRIEVABLE STORAGE

NWPA: Submit R&D plans/report to Congress July 7, 1983; complete required studies, plans and assessments and submit proposal for construction by June 1, 1985.

R&D PROGRAM FOR SPENT FUEL STORAGE

NWPA: Select 1 to 3 reactor sites for licensed co-op demos with utilities by January 7, 1984; conduct up to 300 MTU of demos if necessary at fed sites; conduct generic R&D.

FEDERAL INTERIM STORAGE PROGRAM

NWPA: DOE will provide up to 1,900 MTU of storage capacity where at-reactor capacity is determined insufficient by NRC; fee study to be submitted by July 7, 1983.

INTERNATIONAL COOPERATION

NWPA: DOE/NRC joint notice must be published by April 7, 1983; cooperate with/provide technical assistance.

NUCLEAR WASTE POLICY ACT PROJECT OFFICE BUDGET SUMMARY

[In millions of dollars]

Program	Fiscal year—		
	1982 actual	1983 continuing resolution	1984 congressional request
Nuclear waste fund		217.3	307.6
Commercial waste management [1]	190.3	24.0	6.3
Spent fuel technology [1]	6.8	6.4	5.0
Project office, total	197.1	247.7	318.0

[1] Denotes portions managed by the project office.

Mr. **Lundine**. Would anybody like to see a 3½-minute film on West Valley?

I have actually seen it in person—I mean West Valley, not the film.

Mr. **Roe**. No.

Mr. **Lundine**. I think you can proceed.

Dr. **Brewer**. That completes our formal testimony, Mr. Chairman. We would be happy to respond to any questions you might have.

Mr. LUNDINE. I understand you are going to present separate testimony on the act.

Dr. BREWER. Yes, sir. Mr. Morgan will follow me at the table and discuss the provisions of the Nuclear Waste Policy Act of 1982.

Mr. LUNDINE. With respect to West Valley, Mr. Coffman, is it your plan to use the existing preprocessing plant at that site to conduct the solidification project as you explained you would when the West Valley Project Demonstration Act was adopted?

Mr. COFFMAN. Yes, sir. A basic premise of the conceptual design and planning is that existing facilities will be utilized; only in a last resort case would any new construction be allowed for the project. The present status on that is that many of the contaminated facilities will be cleaned up and utilized.

It now looks like the slurry-fed ceramic melter, which is the only operation where you handle the high level waste in volatile form will need a 25- by approximately 55-foot small hot cell near the chemical processing cell. All of the existing reprocessing cells will be utilized and will be restored after use.

Mr. LUNDINE. From your point of view, is the project on schedule?

Dr. COFFMAN. Yes, sir, I think it is.

I have been personally very impressed with the ability of Westinghouse to manage this project—they took over the site last February—and have established a mission-like approach. I think if you compare the progress at TMI with West Valley, you cannot help but be impressed. They have already cleaned up two contaminated areas and are actively decontaminating and getting the facility fully operational.

Mr. LUNDINE. Do you have any plans to use the solidified West Valley wastes as a part of your research and development repository program?

Dr. COFFMAN. There is a commitment and an agreed cooperation with the repository waste group that we would prepare the waste in such a manner that it would be compatible for use at a test and evaluation facility and, of course, compatible with disposal in repository.

The solidified waste would be available about 1990 and would provide a resource for vitrified wastes should it be needed by the test and evaluation facility. But perhaps Mr. Morgan could comment more on that.

Mr. LUNDINE. I understand this is partly within your jurisdiction and partly in his. Could you please identify all formerly utilized sites that were in any way connected with the Government's civilian research and development activities?

Dr. COFFMAN. Yes; there is a rather long list. I would like, if I may, to provide that for the record. We have it fully listed and also ranked. I would, if I may, provide that for the record.

Mr. LUNDINE. That would be excellent.

[The list follows:]

At the present time there are forty-five (45) sites being considered by the Department for remedial action in the Formerly Utilized Sites Remedial Action Program (FUSRAP) based on work formerly carried out under Manhattan Engineer District (MED) and Atomic Energy Commission (AEC) contracts. Records search is continuing to determine whether additional sites exist which should be included for consideration. The Nuclear Regulatory Commission (NRC) is responsible for evaluating the need for remedial action at formerly licensed sites, but some of these sites could also require consideration by the Department if NRC determines the need for remedial action that is outside the scope of its authority. Within the present list of 45, legislative authority exists for remedial action by the Department, if needed, for only 14.

Work performed for the MED, of course, was fully committed to the initial development of nuclear weapons. During the early years of nuclear energy development under the AEC, it was difficult to distinguish between research and development for the military and that for civilian application. Consideration of sites for inclusion under FUSRAP does not rely on distinctions between military and civilian application, but only on traceable legal liability and authority.

A listing of formerly utilized MED/AEC sites requiring or possibly requiring remedial action follows. The list is in three categories: (1) those sites for which there is legislative authority for DOE action under FUSRAP, (2) those sites for which additional legislative authority is required for DOE action, and (3) those sites where records examination has not been completed and authority remains to be determined.

Formerly Utilized MED/AEC Sites Requiring or Possibly Requiring Remedial Action

Category I: Sites for Which Legislative Authority Exists

1. Gillman Hall, University of California, Berkeley, California
2. University of Chicago, Chicago, Illinois
3. Shpack Landfill, Norton, Massachusetts
3. E. I. DuPont, Deepwater, New Jersey
5. Kellex Corporation, Jersey City, New Jersey
6. Middlesex Sampling Plant, Middlesex, New Jersey
7. Middlesex Landfill, Middlesex, New Jersey
8. Acid/Pueblo Canyon, Los Alamos New Mexico
9. Bayo Canyon, Los Alamos, New Mexico
10. Chupadera Mesa, White Sands, New Mexico
11. Linde Air Products, Tonawanda, New York
12. Niagara Falls Storage Site, Lewiston, New York (offsite only)
13. Bureau of Mines Facility, Albany, Oregon (part of site)
14. St. Louis Airport Storage Site, St. Louis, Missouri (offsite only)

Category II: Those Sites Requiring Additional Legislative Authority

1. Conserv, Nichols, Florida
2. Gardinier, Inc., Tampa, Florida
3. National Guard Armory, Chicago, Illinois
4. Olin Corporation (Blockson Chemical Co.), Joliet, Illinois
5. Palos Park, Site A, Plat M, Chicago, Illinois
6. Ames Laboratory, Ames, Iowa
7. Ventron Corporation, Beverly, Massachusetts
8. Watertown Arsenal, Watertown, Massachusetts
9. Mallinckrodt, Inc., St. Louis, Missouri
10. St. Louis Airport Site, St. Louis, Missouri
11. Ashland Oil Co., Tonawanda, New York
12. Ashland #2, Tonawanda, New York
13. Seaway Industrial Park, Tonawanda, New York
14. Simonds Steel, Lockport, New York
15. Clecon Metals, Inc., Cleveland, Ohio
16. Harshaw Chemical, Cleveland, Ohio
17. Universal Cyclops, Aliquippa, Pennsylvania
18. Pasadena Chemical Co., Pasadena, Texas

Category III: Those Sites Where Authority Remains to be Determined

1. Klassing Hand Brake Co. (W. E. Pratt and Co.), Chicago, Illinois
2. Ravenswood Venture (Quality Hardware and Machine Co.), Chicago, Illinois
3. Bridgeport Brass, Adrian, Michigan
4. Wolverine Tube Co., Detroit, Michigan
5. Revere Copper and Brass Corporation, Detroit, Michigan
6. N. L. Industries, Albany, New York
7. McKinney Tool and Mfg. Co., Cleveland, Ohio
8. Baker Brothers, Inc., Toledo, Ohio
9. Superior Steel, Carnegie, Pennsylvania
10. Premier Mfg. (C. A. Schnour & Co.), Springdale, Pennsylvania
11. Carpenter Steel Co., Reading, Pennsylvania
12. Staten Island Warehouse, Port Richmond, New York
13. W. R. Grace, Curtis Bay, Maryland

Mr. LUNDINE. Would you explain what research and development activities will be coordinated under the UMTRAP program and identify the necessary funding to complete the R&D program in fiscal year 1984 and beyond?

Dr. COFFMAN. Yes, sir. Approximately $10 million has been spent to date on the R&D in support of the uranium mill tailings program. This includes development of covers, membranes, introduction barriers, et cetera.

The consensus of the scientific community is that that work is adequate for us to proceed into title II on sites such as Canonsburg and other sites which utilize the technology, such as Niagara Falls. We are spending about $2 million in fiscal 1983 in an effort to complete that R&D work.

Our contractors tell us that it would be advisable to spend about $150,000 per year to monitor some of the long-term effectiveness of the experimental barriers. But in essence, that work would be completed in fiscal year 1983.

Mr. LUNDINE. Mr. Roe, do you have a question?

Mr. ROE. I don't want to take the time of the committee particularly, but I would like to get a little bit of a feeling on the FUSRAP program. Where do you see that going?

Dr. COFFMAN. If I understand your question, I basically see it as a program which has a substantial number of facilities that must be prioritized and worked off the books, so to speak.

We have some 14 sites which are authorized. These are sites for which there is legal authority on behalf of the Department to assist in the cleanup of those sites.

Mr. ROE. How is that set? Is it set by the Nuclear Regulatory Commission reporting to you, and you have the responsibility to clean that up?

Dr. COFFMAN. The sites were utilized under contracts with DOE's statutory predecessors, and these contract activities were never under NRC license or regulatory control. Remedial action is needed to protect public health and safety at these sites. DOE makes that determination on its own. NRC is not involved.

Mr. ROE. What position are you taking where the Government has acquired materials through contractual agreements with private enterprise? For example, in Wayne, N.J., we have a thorium problem, which I am sure you are aware of. We have been working very closely with DOE and also with the Nuclear Regulatory Commission on that issue.

I wrote a letter to Secretary Hodel just recently and he has responded to me. I don't mean to be unkind, but I am not particularly pleased with the correspondence, because the letter I got back says, "Here is the brochure showing what we are doing on FUSRAP. We have been working on it for 18 months."

So we felt that it was a bit—I realize he is relatively new. We want to get back to you, Dr. Coffman and Dr. Brewer, to get into that, to determine the next steps. We are caught in a never, never land, so to speak, at the moment because we have to get the responsibility. The material has been located. They have done a good job on the technical analysis. I am not faulting that at all. In fact, everything we asked them to do, they followed through and did. We have taken that position.

Of course, on the other hand, we are faced with an enormous emotional situation because we discovered, from those reports, that in the one area, without getting into detail, other trace materials are getting into the water supply, which pretty well now has been verified.

We have written again to the Secretary saying "here is the report, these are the facts. Who is going to now take responsibility? Where do we go from here to get this taken care of?" That is what we want to discuss with you.

Dr. **Brewer**. We are very conscious of the problem at Wayne Township, Mr. Roe. The exact status at this moment, as I understand it, is that the NRC has confirmed the existence of residual contamination at that location. They are now evaluating whether the contamination is compatible with current standards or whether remedial actions will be required.

We are in close touch with the NRC on this.

The W. R. Grace site is not one of the sites that Dr. Coffman mentioned. It is in a gray area. The W. R. Grace site is a formerly licensed site which NRC is studying under its formerly licensed sites program.

Mr. **Roe**. In what respect do you mean? In other words, we know we have documentation where the Federal Government did enter into a contract. The fact of the matter is, NRC recognized that in earlier documentation which gave them authority to move in on the site in the first place. NRC is the one who discovered it, in their remedial and re-review program they brought this to light. So we are not faulting anybody.

The second point, they said that the handle that gave them the authority to move in and to do the preliminary work on it, and the research work that has been done, was based on one of two major contracts, one of which the material went to the Federal Government. That, we know for a fact.

Dr. **Brewer**. The W. R. Grace facility was a licensed facility. Licensed by the NRC.

Mr. **Roe**. Right.

Dr. **Brewer**. Has that license been terminated?

Dr. **Coffman**. Yes. It is inactive.

Mr. **Roe**. That is questionable. Again I don't want to burden this hearing. What we are trying to find out now, which I think is the important thing, somebody has to tell us, "yes; it is blue, green, yellow; or no, let's do nothing." That is part of the reason for the effort.

I trust in that part of the program, FUSRAP program, we can get to the point where we can set up procedures that can be followed. In other words, if for whatever reason the Federal Government comes back and says "we have no direct responsibility, therefore you need remedial action vis-a-vis a change in the law," or you would come back and say, "this is a combination of ours, but there is a private responsibility here," in this instance the W. R. Grace Co. We want that decision to be made so we can move ahead. Otherwise, our constituents, who are coming back to us with information based on the report from NRC that there are many, many times the radiation level than anybody anticipated, are justifiably getting excited. That is obvious.

Dr. **Brewer**. We will be very attentive to the problem. I don't want to sound legalistic and bureaucratic. It is a very real problem. We are awaiting the outcome of the NRC study which will determine if remedial action is necessary.

Mr. **Roe**. Then, in order for us, as responsible citizens, so to speak, representing people, that ought to be reported back to the committee that neither under the present law, for the present situation we have with the 21 projects that we can identify, as we see the picture we don't have the legal room to move. The committee has to decide, Congress has to decide whether or not they are going to go ahead and change the law, whether we should bring in these private parties to be part of this cleanup. I think that is what you have in mind.

Dr. **Brewer**. Yes. We are following this matter closely, and we will report back to you after NRC has made its determination.

Mr. **Roe**. Thank you.

Mr. **Lundine**. We would appreciate that obviously in time so it could be made a part of this year's bill.

Mr. **Roe**. Oh, yes.

Dr. **Brewer**. Yes, sir.

Mr. **Roe**. I think it is essential. You have to pardon me, Mr. Chairman, because I have to leave and go down on the EPA matter. It is essential that we say to the American people, "Look, there are 21 sites that we, the Federal Government, help contaminate and we have an obligation to clean them up." The committee can then take the responsibility to add funds for this purpose rather than drag it out 7 or 8 months. Otherwise, it will only compound public concern on these issues. I think you would agree with me on that.

Mr. **Lundine**. Yes; I certainly do.

Mr. **Roe**. That is all I have.

Mr. **Lundine**. Thank you, Dr. Coffman. I did not say, but I concur with your judgment with respect to the West Valley project, and the progress that Westinghouse is making. I think we are all very pleased to see something that started in the subcommittee progress, at least at this point, as well as it has, and I concur with your judgment.

Thank you very much.

We would now like to hear the testimony of Mr. Robert Morgan, Director of the Nuclear Waste Policy Act Project Office.

Dr. Brewer, are you staying?

Dr. **Brewer**. I will depart at this time.

Mr. **Lundine**. OK. Thank you, too. I wasn't clear on that.

Dr. **Brewer**. Thank you.

Mr. **Lundine**. Mr. Morgan, we have your entire lengthy testimony. It will be made a part of the record. You may proceed as you wish.

STATEMENT OF ROBERT L. MORGAN, PROJECT DIRECTOR, NUCLEAR WASTE POLICY ACT PROJECT OFFICE, DEPARTMENT OF ENERGY, ACCOMPANIED BY MICHAEL J. LAWRENCE, DIRECTOR OF STORAGE

Mr. MORGAN. I would like to make a few brief remarks. I have with me Mike Lawrence, who heads my Storage Office and acts on my behalf when I am not available in the office.

As you are aware, the Secretary established a Project Office in late January reporting to him. I am currently the Project Director.

A permanent organization is under study by the Department. We expect a decision imminently as to where it would fit within the structure of the Department.

At this time we have an adequate staff to do the job. I am getting excellent support from the rest of the Department in carrying out the activities under the act.

I am aware of expressed concerns about the program priorities that have overridden in some cases institutional concerns and process requirements.

One of my first priorities is to balance that so that we meet not only the program activities but the process requirements in the act.

I would first like to review the objectives of the Nuclear Waste Policy Act. They are, in summary, to construct repositories for permanent disposal of nuclear waste by 1998, develop a proposal for the construction of one or more monitored retrievable storage facilities by 1985 and assist utilities in development and licensing of additional at-reactor storage capacity, and provide necessary emergency Federal interim storage.

In the geologic repository area, we are required to issue general siting guidelines within 180 days. We published in the Federal Register on February 7 proposed guidelines, and we are now in the comment period and we do expect to meet the 180-day requirement.

We were required to identify States with potentially acceptable sites for a repository and notify these States by April 1983. Six States were notified on February 2: Louisiana, Texas, Utah, Mississippi, Nevada, and the State of Washington.

We will be holding public hearings in States with potential sites prior to nomination. We intend to nominate five of these sites and recommend three sites to the President in the late summer of 1983.

We have sent letters to 17 States where there are crystalline rock formations. We will identify those potential sites in late 1983.

On the test and evaluation facility, we must submit a report on whether or not to colocate the TEF and the repository by January 1984. We have allocated approximately $1 million in this area to date.

We are currently evaluating the pros and cons of the colocation or separate location. Today and tomorrow we have people from Washington, Nevada, and the ONWI office meeting with us, laying out the potential pros and cons for colocation at each one of the sites, and our support contractor is looking at a separate site location.

We do expect to have a recommendation on this by mid to late summer, which is earlier than required in the act.

We may be reallocating funds in 1983 in order to do some conceptual design activities associated with some of the existing sites for colocation and the Technical Support Office will be doing some conceptual design for other areas.

The budget for 1984 regarding the TEF is zero. We intend to have an additional request into the Office of Management and Budget within 30 days from this point in time.

We also have further budget requirements for the monitored retrievable storage facilities.

On the monitored retrievable storage, we must submit an R&D plan and report to Congress by July 7. We intend to do that. We must complete the required studies, plans, and assessments for submitting a proposal for construction by June 1985.

We consider this as a parallel program to the repositories and will meet the requirements of the act.

On the R&D program for spent fuel storage we are to select one to three reactor sites for licensed cooperative demonstrations with utilities by January 7. We hope to get a solicitation out in April and possibly get those identified in 1985.

We intend to conduct up to 300 metric tons of storage demonstrations, if necessary, at Federal sites, and conduct generic R&D on fuel integrity, storage capability for transportation, and transportation analysis.

On the Federal interim storage program, we will provide up to 1,900 MTU of storage capacity where at-reactor capacity is determined insufficient by NRC.

We will have the fee study done by July 1983.

Regarding international cooperation, we intend to cooperate and provide technical assistance in this area and we are publishing a notice of that on April 7, 1983.

No funding is identified for this area and we will seek to use bilaterals, NEA and IAEA, for any agreements.

Regarding the budget that we look at on a summary basis, the nuclear waste fund in 1982 was zero; the continuing resolution for 1983 is $217 million and our request at this time is $307 million.

In the commercial waste management area, we are now taking care of these activities under the nuclear waste fund.

That dropped because we are currently doing some generic work in R&D and spent fuel technology.

These are the only funds associated with the Nuclear Waste Policy Act project office. It is not the bottom line item under those budget categories. There are some activities under the Assistant Secretary for Nuclear Energy where there remains in the budget some responsibility in the commercial waste and fuel cycle areas.

Mr. LUNDINE. What was the commercial waste management program, just to clarify that? Do I understand what has been categorized as commercial waste management is now being included under what you categorize as nuclear waste fund?

Mr. MORGAN. Yes, sir.

Mr. LUNDINE. Thank you.

Mr. MORGAN. That generally summarizes my remarks.

[The prepared statement of Mr. Morgan follows:]

Statement of Robert L. Morgan
Project Director
Nuclear Waste Policy Act Project Office
Department of Energy
Before the Subcommittee on Energy Research and Production
House Committee on Science and Technology
February 24, 1983

Madam Chairman and Members of the Subcommittee:

I am pleased to appear before you today to discuss the Department of Energy's (DOE's) FY 1984 commercial nuclear waste management and spent fuel storage budgets and these programs. These programs are provided for in the Nuclear Waste Policy Act of 1982 which the President signed into law on January 7, 1983. I am very grateful to this Committee for its help in passing the Act. I also ask for your continued support and cooperation in helping implement the major national objectives of this program.

Secretary Hodel is determined that we mobilize the necessary resources to assure that a mission-oriented coordinated effort is conducted to meet the elaborate set of near-term requirements and actions that are required to be accomplished within the first 180 days by this Act. However, the Secretary and I are also equally committed to following a course that addresses all of the institutional issues and concerns that are of critical importance to the success and ultimate public acceptance of this program. Our concern for adhering to the institutional processes, for instance, consultation and concurrence with State and local Governments, will receive the same consideration as our concern for adhering to the program's technical requirements.

We have recently established a Nuclear Waste Policy Act Project Office. As Director of this Project Office, I shall be responsible for DOE's initial activities to implement the Act. This Project Office will be operational until the Office of Civilian Radioactive Waste Management, established by Section 304 of the Act, is activated. The Project Office will be structured as depicted in Attachment 1. It should be clearly understood that this Project Office is not a permanent organizational structure; it was solely established to implement the provisions of this Act that require action in the near term.

The Act requires major efforts in two primary areas: disposal and storage of spent fuel and high-level waste. Efforts in the former area are to be financed by fees collected from utilities and placed into a Nuclear Waste Fund for disposal services. Under the Continuing Resolution, the FY 1983 appropriation for activities covered by this fund is $217.3 million. In FY 1984, we are requesting an appropriation of $306.7 million. One current waste management activity, subseabed R&D is not eligible for coverage under the Waste Fund and will remain as an element of our annual commercial waste request. In FY 1984, we are requesting $4.7 million for this activity. The Nuclear Waste Fund has become operational. We are in the process of transferring all unobligated appropriations as of January 7, 1983, into the Fund. Initial revenues of $98 million are projected to partially offset this appropriation in FY 1983. During FY 84 and out years, revenue flow will approximate $40 million monthly, based on a 1 mill KWH charge; equalling a half billion dollars on an annual basis. In addition, there presently is existing spent fuel with anticipated revenue amounting to approximately $2 billion dollars in inventory at reactor sites.

The Act provides for Federal storage of up to 1900 metric tons of spent fuel for those utilities that the Nuclear Regulatory Commission (NRC) determines cannot reasonably provide sufficient additional on-site storage. This Federal storage is to be financed through utility user fees that are placed into an Interim Storage Fund. The Act also provides for cooperative research, development, and demonstration activities at utility sites and Federal sites. These activities are to be jointly funded by the utilities and the Federal Government. Lastly, there are generic research and development (R&D) activities in the spent fuel area that are funded from general appropriations. The FY 1983 appropriation under the Continuing Resolution was $6.4 million for the Spent Fuel Storage Program, and the FY 1984 request is $5.0 million. The storage fund may become operational in FY 1983, however, we currently do not forsee a need to transfer any FY 1983 appropriations into the fund, and consequently, the exact date for establishment of the fund may await a signal from a utility that it needs storage services and wishes to sign a contract with DOE for interim storage.

With your permission, Madam Chairman, I shall now highlight the key provisions of the Act and then describe how these provisions are being implemented.

THE NUCLEAR WASTE POLICY ACT OF 1982

Under the provisions of this Act mandated milestones have been established in the areas of fund management, geologic repository, monitored retrievable storage, and spent fuel storage. Specifically, the Act established the following activities in each of these areas:

Fund Management

The Secretary is authorized to enter into contracts with owners or generators of spent nuclear fuel or high level waste for disposal in return for the payment of fees. To implement this activity, the Department on February 4, 1983, published in the Federal Register for public comment a proposed contract which outlines the terms and conditions for making available nuclear waste disposal services and associated financial procedures. The proposed contract will cover transfer of title to the Department, transportation, and disposal of civilian nuclear waste. The contracting party will pay a fee to the Department for such services. Revenues derived from such services will be deposited into the Nuclear Waste Fund. Written comments on the contract and financial procedures must be submitted by interested parties by March 7, 1983. Also, a public hearing will be held on March 3, 1983. Comments received will be assessed and possibly incorporated into the contract for publication as a final rule on April 7, 1983. Owners or generators of spent fuel and/or high level waste will then have until June 30, 1983, to execute the contract with the Department. A standardized contract applicable to all parties is envisioned, although deviations will be permitted for unique circumstances. This timetable satisfies the statutory requirements contained in the legislation.

In addition to developing a contract and financial procedures the Department has developed fee options for existing spent fuel. The selected option will be announced by April 7, 1983, and incorporated into the final contract.

Geologic Repository

o A schedule and associated processes for siting, licensing, and constructing geologic repositories for the disposal of nuclear waste is as follows:

- General guidelines for the recommendation of potential repository sites will be issued by July 1983.
- Five sites must be nominated for detailed site characterization.
- At least, three sites for detailed characterization must be recommended to the President no later than January 1985.
- The President will recommend to Congress by March 1987 the site to be designated as the first repository.
- NRC must act on the license application no later than August 1990. (Assuming DOE License submittal by August 1987)
- The President will submit a recommendation for second repository site to Congress by March 1990.
- In return for payment of fees, DOE will dispose of nuclear waste beginning no later than January 1998.

- o Procedures for participation by States and Indian Tribes.
  - States with potentially acceptable sites for the first repository are to be notified by April 1983.
  - At the request of a notified State, procedures for consultation and cooperation must be specified in written agreements.
  - Public hearings will be required in States in the vicinity of potential repository sites.
  - A State may submit to Congress a notice disapproving of the site finally designated as the repository. Disapproval can only be overridden by a joint resolution.
  - Grants and impact aid will be made available to affected States and affected Indian tribes.
- o A program of research and development, including an underground Test and Evaluation Facility (TEF).
- o Provisions for a Monitored Retrievable Storage (MRS) Program.
  - DOE will submit a report to Congress describing the research and development activities necessary to develop the MRS proposal by July 7, 1983.

  - DOE will complete a detailed study of the need for and feasibility of the construction of one or more MRS facilities and submit a proposal for the construction of the first such facility with supporting plans and analyses by June 1, 1985.

- A Research and Development Program for spent nuclear fuel storage
  - By January 7, 1984, DOE will select one to three reactor sites for a licensed demonstration with utilities of dry storage technologies.
  - DOE plans to conduct an unlicensed demonstration of dry storage technologies, using up to 300 metric tons of spent fuel, at several sites as required to support the licensed demonstration.
  - DOE will conduct generic R&D to support Federal and private storage initiatives.

- A Federal Interim Storage Program
  - DOE will conduct generic R&D to support Federal and private storage initiatives.
  - DOE will provide not more than 1900 metric tons of storage capacity for civilian reactors that cannot reasonably provide sufficient at-reactor capacity.
  - DOE will submit a fee study for Federal Interim Storage by July 7, 1983.
  - NRC determines eligibility for Federal Interim Storage

- A program will be undertaken to cooperate with and provide technical assistance to foreign nonnuclear weapon states in the field of spent fuel storage and disposal.

Disposal Activities

The Act establishes a step-by-step process by which the President, the Congress, the States, affected Indian Tribes, the U.S. Department of Energy and other Federal agencies can work together in the siting, construction, and operation of a high-level nuclear waste repository. One of our priorities is to strengthen consultation and cooperation between DOE and affected States and affected Indian Tribes. The Act provides a firm basis for this cooperation. In this regard, we intend to ensure that a solid technical program is developed and that State, and local, and tribal officials are afforded the greatest possible opportunity to provide input so that together we can move forward toward meeting our national goal of solving the issue of nuclear waste disposal by 1998.

DOE is required by Section 116(a) of the Act to identify States having potentially acceptable sites for a waste repository. A potentially acceptable site is defined by the Act as "any site at which, after geologic studies and field mapping but before detailed geologic data gathering, the Department undertakes preliminary drilling and geophysical testing for the definition of site location." Based on the information acquired thus far, we believe that the states of Louisiana, Texas, Utah, Mississippi, Nevada, and Washington each contains a potentially acceptable site for a repository. Accordingly on

February 2, 1983, Secretary Hodel sent letters to the Governors and legislative leaders of those states formally notifying them of these findings.

As an early step, the Act requires that the DOE issue Guidelines for the recommendation of sites for a repository within 180 days of enactment. The proposed Guidelines were published in the Federal Register for public review and comment on February 7, 1983. These Guidelines will be used to identify and nominate sites for characterization and eventually to determine the suitability of a site for development as a repository. Through consultation with the interested Governors, the Council on Environmental Quality, the Environmental Protection Agency, the U.S. Geological Survey, and with the concurrence of the U.S. Nuclear Regulatory Commission, we plan to finalize these guidelines no later than July 7, 1983, as required by the Act. To facilitate public involvement, we shall hold public hearings during the Guidelines comment period. These hearings will be held in early March in Seattle, Chicago, New Orleans, Washington, D.C., and Salt Lake City.

The next step under the Act is DOE's initial nomination of five locations for site characterization, based on a consideration of the Guidelines and the environmental assessments (EA's) to be prepared for each of the five nominated sites, followed by a recommendation of three candidate sites to the President for his approval. DOE intends to complete these actions in the summer of 1983 in order to permit the conduct of a sufficiently thorough site characterization program at each site to support the Presidential recommendation of a site for the first repository by March 31, 1987, as required by the Act. The Act requires that for each site under consideration, DOE conduct public hearings to solicit recommendations on issues to be addressed in the environmental assessment and in any site characterization plan to be used if the site is approved by the President. The specific date and location for these hearings will be established after consultation with State representatives. Our desire would be to conduct such hearings early in the spring of 1983.

While a great deal of attention has been focused recently on the implementation of the Act, significant and impressive technical progress in the R&D program continues to be made. FY 1982 and early FY 1983 produced many major accomplishments in the site exploration phase of the three primary geologic media being considered for the first repository, basalt, tuff, and salt. In basalt, an exploratory shaft site was selected and the NEPA documentation was completed prior to the enactment of the NWPA. The principal borehole was drilled to the desired repository level and confirmatory hydrologic testing was initiated. Designs needed to start the exploratory shaft were finalized, and construction was started with the drilling of the starter hole in November 1982. In tuff, the conceptual design for an exploratory shaft was completed and a location for the shaft was selected. Drilling and testing of several boreholes to understand the geohydrologic conditions continued. The principal borehole was started and completed. In salt, project exploration achieved definition of specific locations and preliminary study plans in the Gulf Coast salt domes and in the Paradox Basin bedded salts of Utah. In the Palo Duro basin of the Texas panhandle, small areas were defined, and an extensive series of deep drill holes and geophysical tests are nearing completion according to DOE/State agreement. A waste package conceptual design and the preliminary salt explorator shaft design were completed.

As part of the Department's efforts in support of the siting of a second repository, the organization of crystalline rock site exploration has been strengthened by establishment of a field project office. Regional literature based geohydrologic data surveys will be completed in the latter part of the FY 1983 in seventeen states in the eastern United States. These studies will culminate in the defintion of specific rock units for field studies in FY 84 and beyond.

Numerous public meetings have been held throughout the year to explain our efforts to state officials and the public.

In FY 1984, the program begins a transition from the research phase to the engineering development phase. In basalt, drilling of an exploratory shaft will be completed and repository design studies will continue. In addition, at depth testing in the preferred reporitory region will be initiated. In tuff, the exploratory shaft mining will be inaugurated. Confirmatory site characterization will continue. In salt, drilling at the location of an exploratory shaft will start and site specific hydrologic and geologic testing will continue Additionally, R&D will continue on waste package design, materials characterization, and transportations studies. The aim of this overall work is to develop the data to assist a Presidential site selection and subsequent repository license application for a first repository in the mid to late 1980's.

With regard to the Test and Evaluation Facility, the Department is currently evaluating the role, benefits, and costs of the TEF and whether or not to collocate it at the repository site. Public Law 97-425 requires the Department to present to Congress within one year of enactment, its recommendations regarding the location of the TEF. The Department has initiated an evaluation of the the role and benefits of the TEF with respect to its timeliness and its capability to provide additional information to resolve generic and site specific technical issues (engineering and siting) via insitu tests using up to 100 canisters of high-level waste. The advantages (such as site specific information, design optimization and performance verification) and disadvantages (such as timeliness of TEF construction relative to repository site identification, licensing schedules and funding and manpower requirements) of collocation vs. noncollocation (which will not yield site specific information, but could provide earlier TEF construction start) are currently being evaluated.

I also wish to describe those activities which do not qualify for financial support from the fund but directly involve the Project Office. These activities include Terminal Isolation Generic Research and Development, and supporting studies.

Generic R&D

The objective of the Commercial Waste Management program is to support technology related to the long-term management and disposal of commercial radioactive waste. Specific activities include: (1) basic generic R&D for the geologic disposal of commercial waste; and (2) studies to support the combined commercial waste management activities, and to obtain international and technical review coordination.

The FY 1983 repository siting activities include development of measurement methods for laboratory testing of host rocks and radionuclide migration through rocks. An integrated generic performance assessment model to predict potential release and migration rates from a repository will be developed. The preliminary waste acceptance criteria and specifications will be defined. The FY 1983 repository development activities include completing development of and testing of repository sealing and backfill systems. Equipment and instrumentation for in-situ testing and performance monitoring will be developed and tested.

The only generic R&D efforts remaining in the Terminal Isolation program in FY 1984 are associated with alternative disposal concepts R&D which currently is the subseabed research effort. This effort is directed toward establishing the feasibility of the subseabed disposal concept. If feasibility is established, it will provide the basis for removal of institutional restrictions on disposal in subseabed. In FY 1983 a technical status report will focus on the critical feasibility issues for the subseabed activities including the completion of sediment models for predicting the effects of emplaced waste. A free fall test boosted pentrometer tests and an in-situ heat transfer experiment will be designed. These tests are precursor to determining the feasibility of the actual subseabed disposal. These efforts will lead to the completion in FY 1991 of the assessment of this disposal concept's feasibility.

Supporting Studies

The Supporting Studies task includes three main areas of effort: international program support, special technical reviews by prestigious scientific groups, and independent assessment of programmatic and institutional issues. The thrust of these efforts is to assure mutually benefical cooperation, to provide an independent assessment of the technical adequacy of the program, and to evaluate potential alternatives which could improve the cost, schedule, or technical aspects of the Commercial Waste Management programs. During FY 1984 the International program efforts will support international, bilateral, and multilateral agreements. Summary reports will be prepared on the various international programs of the various countries emphasizing the status and planning of international waste management activities. International cooperation on experimental projects and exchange of information provides the fundamental basis for many other countries to resolve the pressing issue of disposal of Nuclear Waste. The information exchange contributes to the development of international consensus on the adequacy and safety of geologic disposal of Nuclear Waste.

Also, in FY 1984, support of special technical reviews by the National Academy of Sciences will continue. Effort will also continue on independent assessment of technical and programmatic issues related to the integration and conduct of the Waste Management and Fuel Cycle activities.

As I mentioned earlier, the Act requires major efforts in two program areas: Disposal and Storage. Having discussed the former, let us now consider the programs for Monitored Retrievable Storage and Interim Storage of Spent Nuclear Fuel.

Monitored Retrievable Storage

The Department is directed to complete by June 1, 1985, a detailed study of the need for and feasibility of construction or one or more MRS facilities and to develop the specific proposal required under Subtitle C of the Act.

This proposal is to include:

1. A proposal for the construction of one or more monitored retrievable storage facilities. The proposal is to contain at least five alternative site-specific designs at a minimum of three different sites.

2. An accompanying Environmental Assessment.

3. Establishment of a Federal program for the siting, development, construction, and operation of MRS facilities.

4. A plan for funding the construction and operation of MRS facilities such that the costs are borne by the generators of the spent fuel and waste.

5. A plan for integrating the MRS with repository and spent fuel storage facilities.

In FY 1983, the Department will concentrate on identifying the proper role and scope of monitored retrievable storage including its possible integration into the storage and disposal systems and selecting specific storage concepts based, in part, upon the previous MRS studies conducted by DOE and industry. Also, a report describing the research and development activities necessary to develop the required proposal will be prepared and submitted to a Congress in July 1982 as required by the Act.

Spent Fuel Interim Storage

Implementation of the spent fuel storage provisions of the Act is predicated upon the primary responsibility for storage remaining with the utilities. Federal actions are limited to: 1) encouraging and expediting effective use of existing at-reactor storage capacity through research, development, and demonstration along with consultative assistance and 2) providing up to 1900 metric tons of Federal storage for use by utilities who have been certified by the Nuclear Regulatory Commission as having exhausted other reasonable alternatives.

1. Spent Fuel Storage Research, Development, and Demonstration Activities

As directed by the Act, DOE intends, within one year, to enter into a cooperative agreement with one to three utilities desiring DOE assistance in at-reactor demonstrations of spent fuel storage technologies. A DOE "Solicitation for a Cooperative Agreement Program (SCAP)" is in preparation for issuance in the near future. This solicitation will describe the scope of DOE assistance to be provided and invite utility proposals. FY 1984 activities will consist primarily of implementation of these new agreements.

These new agreements will supplement activities currently underway under existing cooperative agreements with the Tennessee Valley Authority that provide for the demonstration of rod consolidation equipment and the use of two new storage casks suited for Boiling Water Reactor fuel. It is planned for these demonstrations to commence at TVA in 1984 upon receipt of an NRC license.

In support of the at-reactor demonstrations, DOE is authorized to do unlicensed demonstrations for dry storage at DOE sites using up to 300 metric tons of spent fuel. The scope and size of this program will be determined based upon discussions with NRC and the private sector and upon responses to the SCAP dealing with this aspect of the program. Depending upon the scope and timing of specific proposals that are accepted, data collection efforts could be initiated in FY 1984 in addition to modification of Federal sites to implement this program.

Several generic spent fuel storage R&D activities are already being conducted by DOE and will continue in FY 1984. Summaries of these activities and planned new activities will be communicated to the utilities to obtain comments and identify any new R&D needs. Generic R&D activities include investigations of fuel integrity under various storage conditions and the development and refinement of analytic tools for predicting the performance of fuel and storage components for use in licensing proceedings and as needed by the spent fuel storage technical community.

2. Federal Storage

The Act assigns the responsibility to DOE for interim storage of spent nuclear fuel from those civilian nuclear power reactors that cannot reasonably provide storage needed to assure their continued, orderly operation. The capacity provided by this program shall not exceed a total of 1900 metric tons. Following an NRC determination of a utility's eligibility for interim storage, DOE will enter into contracts with the utility, take title to their fuel, provide the storage capacity for this fuel at a DOE site, ship the fuel to the storage site (using private industry under contract to provide these services), and store the fuel pending availability of disposal or other storage facilities.

FY 1983 activities will focus on submission of an interim storage fee study to Congress by July 1983, preparation of Annual Storage Plan to be submitted to Congress by January 1984, studies leading to the selection of technology and site options for deployment of Federal storage, interactions with State and tribal governments as necessary, and other activities to support the above. The NRC, possibly in early FY 1984, could determine that several utilities are eligible for Federal storage; in which case DOE could enter into contracts and begin collecting fees for this storage later in FY 1984. We are currently reviewing the possible options for storage identified in the Act to determine specific storage options to be selected.

Other FY 1984 activities will consist primarily of a continuation of activities initiated in FY 1983 as well as initiation of new activities leading to the actual deployment of storage options if contracts are signed.

One additional item I wish to cover is the planned activities with respect to Section 223.

Technical Assistance to Nonnuclear Weapon States

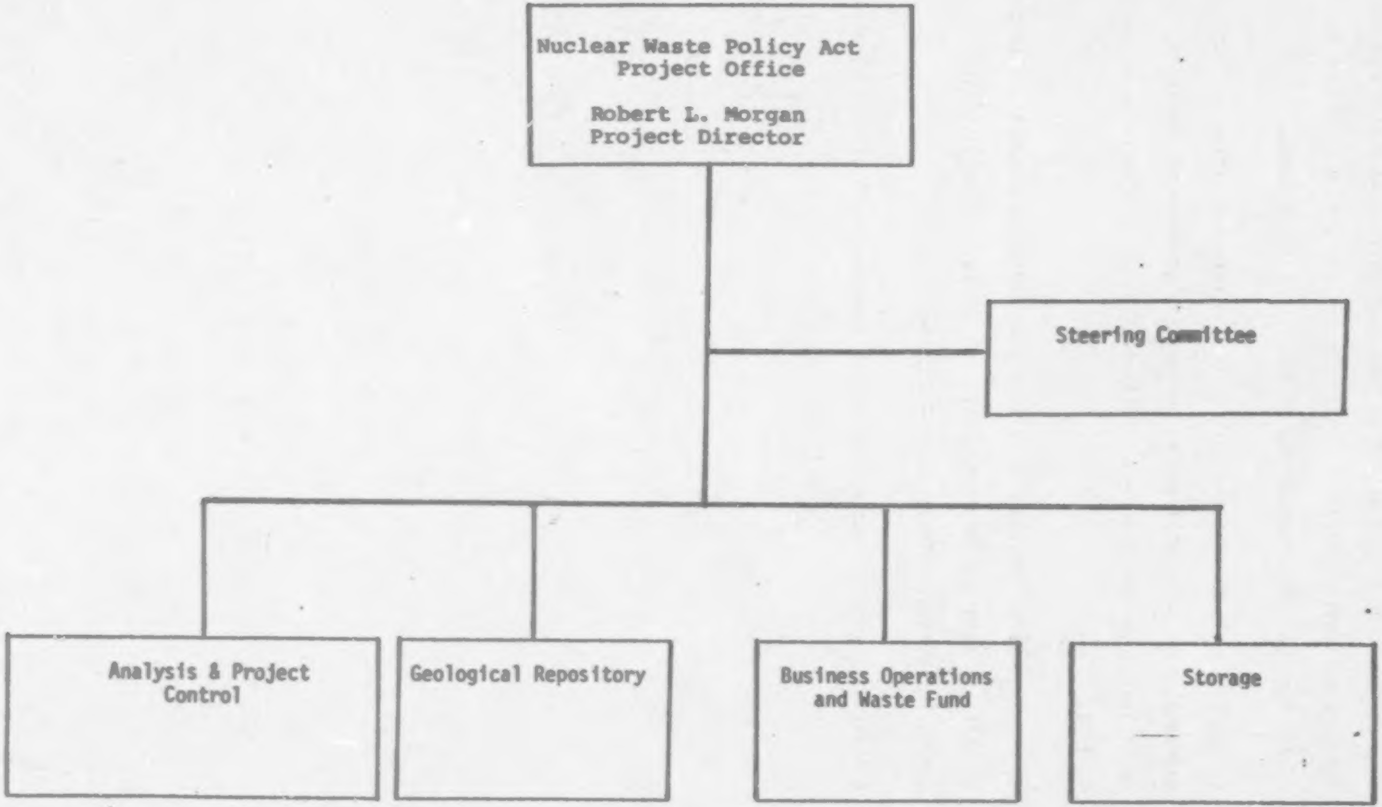
The Act stipulates that it shall be the policy of the United States to cooperate with and provide technical assistance to nonnuclear weapon states in the field of spent fuel storage and disposal. The Act requires that by April 7, 1983, the DOE and NRC publish a joint notice in the Federal Register announcing this policy. The notice will also summarize activities being proposed for international cooperation. This cooperation will not include the transfer of any foreign spent fuel to the United States for storage.

Following publication of the notice, the Secretary of State will solicit expressions of interest from the appropriate governments concerning their participation in the program. Implementation of this offer could begin in FY 1984.

In closing, Madam Chairman, I solicit your continued support and cooperation so that the major national objectives of the Nuclear Waste Policy Act of 1982 can be implemented effectively and on time.

I shall be pleased to attempt to answer your questions at this time.

Attachment 1


Nuclear Waste Policy Act
Project Office
Robert L. Morgan
Project Director
Steering Committee
Analysis & Project Control
Geological Repository
Business Operations and Waste Fund
Storage

U.S. Department of Energy
Assistant Secretary for
Congressional, Intergovernmental
and Public Affairs
Office of Public Affairs
Washington, D.C. 20585
202/252-5644

BIOGRAPHY

ROBERT L. MORGAN

Robert L. Morgan was appointed Director, Nuclear Waste Policy Act Project Office on January 31, 1983. This is an interim assignment until the permanent establishment of this office.

Mr. Morgan was appointed Manager of the Savannah River Operations Office, U.S. Department of Energy, on March 1, 1980.

He began working with the U.S. reactor development program in 1959 while with the U.S. Army at the Idaho Operations Office of the then, Atomic Energy Commission.

In June 1965, he resigned his commission and accepted a position as Assistant Director of the Civilian Reactor Division at Savannah River. On August 1, 1965, he was appointed Director, Heavy Water Organic Cooled Power Reactor Program (HWOCR) Division. In that position, he was concerned with the development of work in the HWOCR program and when the program was transferred to Canogo Park, California in 1966, Mr. Morgan became the Senior Representative at that site for reactor development programs.

Mr. Morgan rejoined the staff at Savannah River in July 1973 as Deputy Manager. In November 1977, he was detailed to the Department of Energy's Headquarters in Washington where he first served as Acting Director for Field Operations Management for the Assistant Secretary for Energy Technology. In May 1978, he was assigned as Acting Director of the Office of Nuclear Waste Management. He returned to full time status at Savannah River in November 1978 where, in addition to his duties as Deputy Manager, he also served as Assistant Manager for Health, Safety and Environment.

In February 1981, Mr. Morgan was once again detailed to DOE's Washington Headquarters to serve as Acting Assistant Secretary for Defense Programs, and in July 1983, as Acting Deputy Under Secretary.

In these later positions, as well as Deputy Manager and Manager at Savannah River, Mr. Morgan has had, on a continuing basis, frequent interaction with other Federal agencies, state government officials, and regional planning councils. He serves as the Department's representative to the Southeastern Federal Regional Council (SFRC).

Mr. Morgan graduated from the U.S. Military Academy in 1952 with a B.S. degree, and from the Massachusetts Institute of Technology in 1959 with M.S. degrees in Civil and Nuclear Engineering.

He is married to the former Arden Park of Hayward, California, and they have three children. They reside in Aiken, South Carolina.

February 1983

Mr. **Lundine.** I would like to divide my questions into various categories, the first being the mission plan. It is of particular interest to me to see that the mission plan for the Department's activities under the act is properly prepared and sent to the committee and others interested in a timely manner.

I notice that your 1984 budget request contains no mention of the mission plan and no request for funds to prepare it. Do you not need any money for this purpose?

Mr. **Morgan.** We believe we can adequately handle that under the existing funds, sir.

Mr. **Lundine.** How do you propose to prepare the mission plan? Will it be developed basically in-house or will you contract with consultants?

Mr. **Morgan.** It will be in-house, and we do have a technical support contractor who will provide us support in that area.

Mr. **Lundine.** Has that contract already been entered into?

Mr. **Morgan.** The contract is currently under the source evaluation board, and they are to make a recommendation to me next week. I am to decide on the contract selection at that time.

Mr. **Lundine.** But you have not decided; you don't have a contractor at the present time?

Mr. **Morgan.** I have a contractor now. ONI is helping us at this time. This new contract is basically replacing that contract. I do have a support contract but there is a new support contract under evaluation at this time.

Mr. **Lundine.** I understand that the Department has shifted personnel and that some people that are involved in the development of the policy with respect to the mission plan are development people that, frankly, otherwise would have been RIFed, and they have no or little experience in waste management. Can you clarify or enlighten me about that?

Mr. **Morgan.** There have been some people that were placed on detail from the Office of Policy Planning and Analysis. They were on detail to the Assistant Secretary for Nuclear Energy until this project office was established. Those people have been integrated into the organization that I now head, and they are participating in these areas. Because many of them have technical backgrounds and they have a capability in planning and analysis we are fully utilizing them.

As to when a permanent organization is established, we will go through a selection process to be sure that everybody has the right skills and abilities as well as experiences to fill the job descriptions.

They have been extremely helpful to me during this time and it was not saving anybody from a RIF situation.

We need the people and we are utilizing them now, Mr. Chairman.

Mr. **Lundine.** And you feel very confident about their capability to provide you with that policy assistance?

Mr. **Morgan.** They are doing a very good job for us now.

Mr. **Lundine.** What about the timetable for the mission plan? The Nuclear Waste Policy Act allows 15 months to complete the first draft, as you know. And the final plan should be submitted to Congress within 17 months.

In order to allow time for States and others to react to it, would it be possible to complete the draft before the 15 months?

Mr. **Morgan**. We intend, as we go through the process, integrating the various aspects or sections of the act, to keep people fully informed, particularly the States and the congressional committees and to have a dialogue before we put the plan out in the 15-month period.

Mr. **Lundine**. With respect to the test and evaluation facility, I likewise see that there is no budget requested for that. Can you explain why?

Mr. **Morgan**. At that point in time we were concerned as to putting in a number. We are not sure what that is.

As I stated earlier, we intend to submit to the Office of Management and Budget, within 30 days, a budget for 1984 for TEF.

We are currently evaluating whether that should be colocated or located independently. There are different funding scenarios associated with each one of those because if you locate it away from an existing facility it might require more funds initially, but certain demonstration activities would begin earlier.

So those are the balancing factors that we are weighing.

Mr. **Lundine**. You did not colocate it?

Mr. **Morgan**. Yes, sir.

Mr. **Lundine**. It would require more funds initially but not as much eventually?

Mr. **Morgan**. I said that it also would allow you, if you were to go into an existing location and not use any radioactive waste in that location, to demonstrate down-hole equipment and other things that would be of assistance to whatever site or repository site scenario is decided upon later.

So there are pluses and minuses. We are reviewing those as to the colocation or locating separately. We will have that decision by late summer, but we will have the funding requirements as we see them for both a colocated and a separate site within 30 days.

Mr. **Lundine**. With respect to the T&E facility, what are some of the factors that you would consider both in deciding whether to proceed with one at all and whether to colocate it with the permanent repository?

Mr. **Morgan**. As I recall, there are 17 factors that are established in the Nuclear Policy Act. We would intend to use all of those factors in those evaluations as required by the law.

Mr. **Lundine**. But are any particularly significant to you in your mind? Do any stand out as particularly important?

Mr. **Morgan**. I believe they are all important but I have not gone through and weighted each one of those, but I will be sure that they are addressed.

I have not been briefed. The first meetings are going on today and tomorrow, Mr. Chairman.

Mr. **Lundine**. Mr. Chandler, do you have questions?

Mr. **Chandler**. Yes, thank you, Mr. Chairman.

Mr. Morgan, you may know I am from the State of Washington and, of course, we have a keen interest in the potential site at Hanford.

To preface my question, I know now that, of course, we are talking about an expenditure of funds off budget, which makes it far less sensitive, but it is nevertheless coming from people who use power to pay for the disposal of nuclear waste. Therefore, I think all the expense of the elimination of this waste must certainly be a concern to us.

This reminds me of a question that has arisen on the subject of site location. Rather than going beneath the surface of the Earth in that flat section near the river, wouldn't it be a far less costly process, taking Hanford as an example, to utilize the hills that are adjacent to that area?

As I understand it, we are talking about burying waste which is glassified and then encased in stainless steel and the likelihood of any leaching from that even in a great deal of water is extremely remote.

Therefore, I am just wondering whether you are considering this as an alternative on that same site; whether you feel—of course I recognize you are trying to protect the public health and safety—if this isn't an alternative that does deserve the consideration of the Department.

Mr. MORGAN. I believe that it has but I will defer that to Mr. Lawrence.

I believe that in that area it would be in an unconfined aquifer; whereas with deep mining in the geology, you would be in a confined aquifer that had no potential of contaminating the Columbia River Basin.

Mr. LAWRENCE. As you know, we have been studying the Hanford location and the basalt formation in that area for many, many years. The selection of the principal bore hole and exploratory shaft site for Hanford was based upon very detailed consideration of all the potential sites around there, including the mountains.

It was felt that the location they selected was the best for a potential repository. Of course, that is what the exploratory shaft work and detailed site characterization at depth has to confirm.

Obviously, the ability of that formation to prevent any significant migration of radionuclides over time is essential for a repository. Certainly, we wouldn't propose putting any waste there unless that is confirmed, regardless of location.

Mr. LUNDINE. Is Mr. Morgan correct when he indicates that in those mountains near the Hanford site there is an aquifer that you have ruled out as a potential site?

Mr. MORGAN. The area that I am talking about is in that specific area where the exploratory hole is. The first 620 feet down from that hole is what they consider the surface area which does have unconfined aquifers in it.

The basalt level starts at approximately 620 feet below the surface level.

Mr. CHANDLER. Is my impression correct—and I am simply repeating what has been related to me by what appear to be some knowledgeable people—that it would be far less expensive to utilize a mountainous area so that you in a sense tunnel rather than drill down; is that correct, that that would be less expensive?

Mr. MORGAN. Yes, sir, it would be.

Mr. CHANDLER. Are you considering any other sites that would have this kind of formation that you could perhaps use?

Mr. **Morgan**. The only area in which we are considering those types of formations is the potential for a monitored retrievable storage, but not a permanent geologic repository.

Mr. **Chandler**. Thank you very much.

Thank you, Mr. Chairman.

Mr. **Lundine**. You just anticipated something I was going to ask him to yield about, but you answered my question before he finished.

Mr. Walker.

Mr. **Walker**. Thank you, Mr. Chairman.

I understand that 6 other States in addition to the original 5 are being considered as possible primary repository sites, and 16 other States have been notified that they potentially could be considered as secondary sites.

I want to just try to clarify that process a little bit, because I understand that one of those States is Pennsylvania which has been notified that there are crystalline deposits in Pennsylvania that might potentially serve as a secondary site. Could you give me a bit of information as to what that means in terms of secondary siting and what the ramifications are for the States that have been so notified?

Mr. **Morgan**. I will have Mr. Lawrence respond to that.

Mr. **Lawrence**. Yes. The Waste Act requires that by 1989 sites for detailed characterization for a second repository be identified and that the President recommend such a site for a second repository by 1990.

In order to meet those schedules, our current plan is to do studies in the 17 States which have been notified.

Mr. **Walker**. Seventeen rather than 16?

Mr. **Lawrence**. That's right, there are 17 States.

Mr. **Lundine**. If the gentleman will yield, that is 17 total?

Mr. **Lawrence**. Seventeen total. Now, there are 6 States, as Mr. Morgan indicated earlier, that have been notified that they have potential candidate sites and are under consideration for the first repository.

Mr. **Lundine**. Right.

Mr. **Lawrence**. Those are potential candidate sites as defined by the law. There are 17 States in which we are currently conducting studies on crystalline rock formation located in those States in addition to the 6.

Mr. **Lundine**. In addition, so there is a total of 23 States in one way or another?

Mr. **Lawrence**. Under consideration for the first or second.

Mr. **Lundine**. I just wanted to get that clear.

Mr. **Lawrence**. The six States were notified they are potential sites for the first repository; a similar notification is planned to be made late this year for any crystalline rock sites so that any State in the East, one of those 17 which would be designated a potential candidate site, would be done late this year. And, at that time, those States would be eligible for cooperative agreements with the Department as laid out in the act.

That process will go on, such that siting work can go on prior to the recommendation of sites for detailed characterization which is called for in the act no later than 1989.

Mr. **Walker**. The notification the States have received now is not an indication that you have already found that they are—that there are sites there which are acceptable; only that the geologic formations there may indicate that there is a suitable site there?

Mr. **Lawrence**. That's correct, based upon existing information they have crystalline rock formations which are of interest.

Mr. **Walker**. Let me see if I understand the timetable again. When are they to be evaluated as to whether or not there is a real potential site there?

Mr. **Lawrence**. We will identify potentially acceptable sites by the end of this year and so notify those States.

Mr. **Walker**. What kind of study is involved to do that, a geological assessment?

Mr. **Lawrence**. I do not believe geologic studies are planned at this time.

Mr. **Morgan**. There would not be any anticipated bore holes, but, using existing data from mines and other geologic information, you would then try to narrow down where the more appropriate areas would be, but not doing exploratory shafts in all those States.

Mr. **Walker**. So sometime before the end of this year we are going to have some of those 17 States notified that they in fact are candidate States?

Mr. **Morgan**. Potential candidate States.

Mr. **Walker**. Then when would be the next timetable decision as to whether or not—when do we start drilling bore holes, look at the geology, when do we decide whether or not some of those States are going to be narrowed further?

Mr. **Morgan**. This is currently under evaluation because of a discrepancy of two dates in the law. One that says recommend the site in 1989 and then make a decision in 1990. That is an inadequate amount of time to perform the appropriate activities for exploration.

We feel that one of those dates has to be moved around 3 years. The 1989 date being moved forward or the 1990 date being moved backwards.

So, I am currently resolving that issue and discussing it with the Secretary of Energy relative to that portion of it. Until this issue is resolved, the in-between steps are still uncertain.

But my interpretation is that we would have to move the 1989 date forward by at least 2 to 3 years in order to comply with the other dates in the act that say not later than 1990.

So we have not resolved that specific date. I expect to do that shortly. When it is done we will so notify the committee.

Mr. **Walker**. Just one other question. Then what I would like to do is get permission to submit some questions in writing.

Mr. **Lundine**. Without objection, it is so ordered.

[Questions are included in the appendix.]

Mr. **Walker**. Then also can we get permission for questions in writing from Mr. Lujan on subseabed disposal?

Mr. **Lundine**. Without objection that will be allowed.

[Questions are included in the appendix.]

Mr. **Walker**. One other question, then, with regard to this timetable.

Do I understand that weighing in other factors with regard to site selection, everything from environmental factors to community factors, all of that, that would not come before the end—probably toward the end of the next decade; is that what the law now says?

Mr. MORGAN. That is my understanding, yes.

Mr. WALKER. Thank you, Mr. Chairman.

Mr. LUNDINE. Mr. Morgan, with regard to the repository program, are you familiar at least in general with an article in Science Magazine, January 7, 1983, with respect to some of the technical issues associated with basalt development at Hanford and the TUFF development in Nevada?

Mr. MORGAN. I am not familiar with that article, Mr. Chairman.

Mr. LUNDINE. It raises several very interesting points with regard to the geology in these areas. What I would like to ask is that the article be made a part of the record and then for the opportunity to ask you a question in writing about it.

Mr. MORGAN. Certainly we will respond.

Mr. LUNDINE. I presume you would rather not answer a question about an article you haven't read.

Mr. MORGAN. We will submit any answers for the record.

Mr. LUNDINE. Thank you. Without objection, that will be allowed.

[The article follows:]

[From Science, Jan. 7, 1983]

THE RADWASTE PARADOX

POLITICAL PRESSURES PUSH FOR A SPEEDING UP OF THE GEOLOGIC DISPOSAL PROGRAM, BUT TECHNICAL CONSIDERATIONS MAY CALL FOR A SLOWING DOWN

Early explorers and settlers of the Colorado Plateau, in coming to a deep bathtub-shaped valley just east of what is now the Colorado-Utah state line, were astonished at how the Dolores River, a tributary of the Colorado, cuts across the valley and through its steep walls at right angles. They called this place "Paradox Valley," and the much larger geologic province in southeastern Utah and southwestrn Colorado of which the valley is a part was to become known as the Paradox Basin. As it happens, the Paradox Basin is one of the places where the U.S. Department of Energy (DOE) is looking for a site for a deep-mined repository for high-level radioactive waste. This seems appropriately symbolic because the geologic disposal problem has increasingly taken on the aspect of a political and technical conundrum, replete with real or seeming contradictions and paradoxes.

A central paradox is that, while the concept of sequestering long-lived wastes in mined repositories is attractive intuitively, the very efforts made to confirm the suitability of particular rock formations give rise to further uncertainties, at least in the early years of the site investigations. Overcoming these uncertainties, which are arising in every rock type and at virtually every site under investigation, takes time and may in some cases require the stretching out of schedules. But under the radwaste legislation approved by Congress last month (see box) the present DOE schedule for site selection and licensing could be accelerated by more than 2 years. The new law contemplates that, barring certain discretionary extensions, repository construction will start as early as 1989.

This is 6 years away and many people in Congress and the nuclear industry find it hard to understand why it should take any longer than that to find a suitable site and begin excavating a mine and getting rid of the waste. The scientific and technical questions associated with deep geologic disposal of radwaste—especially heat-generating high-level waste—are sufficiently specialized and obscure that for most people it seems that, as the saying goes, "you can't appreciate the problems until you get there."

Top DOE officials have themselves sought to push the geologic disposal program to a faster pace than the one DOE was following at the end of the Carter Administration. "I've tried to see that the schedule is accelerated," Deputy Secretary of

Energy Kenneth Davis told *Science*, adding that a congressional mandate for a still faster schedule "could be helpful." In his view, it is likely that not just one but several of the sites under investigation will be usable. "I don't see a problem," he said. "My expectation is that it will be a question of which one to choose, not which one is acceptable."

PUBLIC HEALTH AND SAFETY DOES NOT REQUIRE EARLY DISPOSAL

DOE and the nuclear industry are feeling pressure from Congress and the public to demonstrate final disposal of radwaste. Public health and safety does not require early disposal; indeed, with passage of time the radioactive decay of the shorter lived fission products reduces the waste's heat and makes ultimate disposal easier. The pressure to move quickly is political and stems from the fact that, with the nuclear enterprise now in its fourth decade, it is an acute embarrassment that the waste problem has not been solved.

These circumstances seem to have produced what are in a sense two facets to the geologic disposal program. One is the difficult, time-consuming, brow-mopping research and development effort that the DOE staff people and contractors are struggling to carry out in the field. The other is the self-confident, briskly paced program that the nuclear industry and its supporters in Congress and the higher echelons of DOE see as vital to the industry's political needs and ultimate survival.

The National Waste Terminal Storage (NWTS) program, as the DOE geologic disposal effort for commercial high-level waste is known, is large and far-flung, especially compared to radwaste disposal programs abroad. In Germany, which has gone further than any other foreign country in its efforts to establish a radwaste repository, the geologic investigation has focused exclusively on one rock type, salt, and on the one site, the Gorleben salt dome of Lower Saxony. By contrast, DOE, to hedge its bets and to meet the requirements of the Nuclear Regulatory Commission (NRC), is investigating multiple rock types and multiple sites. Moreover, the sinking of large exploratory shafts at three sites is a prerequisite to the filing of a repository permit application. The shafts will allow lateral entry into and testing of the rock formation at the repository horizon.

The multiplicity of sites and rock types in part reflects a political need to "spread the misery" by demonstrating that no one part of the nation will be expected to bear the entire burden of nuclear waste disposal. Taken overall, the NWTS program constitutes an enormous geologic research effort; its budget is now approaching a quarter of a billion dollars a year and is rising.

Furthermore, by virtue of political circumstances, the demands of the NRC and the National Environmental Policy Act, and DOE's own sense of technological caution, the department is committed to an elaborate program review process in which the agency not only solicits but pays for kibitzing by outsiders. The U.S. Geological Survey (USGS), for instance, has recently been brought into the program to a far greater extent than ever before. Similarly, most of the potential repository host states are becoming increasingly involved in the review of program plans and data pertaining to the investigation of sites within their boundaries; in some cases these DOE-state relationships have been going acrimoniously, in others more harmoniously, but with the exception of Nevada, all of the host states have chosen to enter into formal arrangements of one kind or another with DOE whereby they are supposed to receive project information regularly.

To find sites for the two repositories that are expected to be needed by early in the next century, investigations have been under way for some time in four different kind of geologic formations in six states: the old basalt lava flows of the Columbia Plateau at DOE's Hanford facility in Washington; the welded tuff (another kind of volcanic rock) at the Nevada Test Site, not far from Las Vegas; bedded salt in the Paradox Basin of southeastern Utah and the Palo Duro Basin in the West Texas panhandle; and salt domes in Louisiana and Mississippi. Within a year or so field work is expected to start in the Precambrian shield granite of the upper Midwest and in the granite of the Appalachian Mountains.

The next major step in the NWTS program is to come in 1983 and early 1984 with the sinking of exploratory shafts at Hanford and the Nevada Test Site, in basalt and tuff, and at a salt site to be chosen from among the four salt locations which DOE still has under investigation. One of the three sites picked for exploratory shafts will, under the present DOE schedule (which the radwaste legislation may accelerate), be selected for a licensing application by 1988. Also, either at one of these sites or at some other, an unlicensed "Test and Evaluation Facility" for temporary storage of a few hundred waste canisters would be built and put in operation by the fall of 1989. A second repository site would be chosen in the early 1990's.

But the experience so far at the several sites suggests that the technical and political questions tend to proliferate rather than diminish as more becomes known about the geology and hydrology.

The Hanford basalt. The priority being given the Hanford basalt and the Nevada tuff has not come about because those geologic media have been known from the first to be suitable for radwaste disposal. In fact Rockwell International, the DOE contractor at Hanford, was called to account in 1981 by its Hydrology and Geology Overview Committee (a group made up largely of university-based scientists) for stating that the Hanford basalt was under study "because of the favorable geology of the site."

The committee observed: "We trust this is not a representative attitude. There is really only one solid justification for studying this site and it is the sociopolitical fact that the land is a U.S. nuclear reservation. From a hydrogeological perspective, the Columbia River Basalt Group as a whole is not well suited for a high-level waste repository. It may well be that with further data and/or careful engineering design it can be shown to be acceptable, but it cannot be stated that the 'geology is favorable.' "

The political climate for the basalt project is more or less sympathetic in the Hanford vicinity, where the people have long been familiar with things nuclear. But elsewhere in the state attitudes are reserved, to say the least. In 1980, Washington citizens voted overwhelmingly for a ballot initiative to limit or prevent nuclear waste—high as well as low level—from being shipped in from outside the state (a law that has since been declared unconstitutional). Governor John Spellman, with support from DOE, has recently established a task force to bring the basalt project under close state review.

DOE realizes that it is on its mettle to show that the basalt investigation is being conducted in a rigorously scientific manner. The participation of the USGS in this investigation has in recent months been earnestly solicited. This marks a big change from the late 1960's and early 1970's when the basalt studies were starting under ARCO, the DOE contractor at the time. The USGS scientists found ARCO so unresponsive to their suggestions and critiques that they chose to withdraw.

Now the USGS is focusing on the hydrologic regime in the basalt, in particular on the possible pathways by which radionuclides could be transported from the repository site to the Columbia River. Rockwell believes that the discharge point is quite distant and that it would take 40,000 years or longer for radionuclides to reach the river, an estimate which if accepted would satisfy regulatory criteria by a wide margin.

But the USGS has not yet reviewed Rockwell's data or its data-collection methods, and remains to be convinced. "We feel that the groundwater flow system could be discharging all along the river.,' John B. Robertson of the USGS told Science. To resolve this issue, a special review group has been established, with Rockwell, the Battelle Pacific Northwest Laboratories, and the USGS all participating, and with the Lawrence Berkeley Laboratory serving as referee.

But a variety of other questions also has been raised. For instance, fractures found in core samples suggest that the besalt is under high horizontal compressive stress. Besides complicating the design and construction of the repository, the stress might induce fractures and create new pathways for radionuclides to escape.

Now there is even a question whether the very large, 20-foot-diameter shaft needed for a repository could be constructed deep into the basalt. "At the moment, a big issue is can they in fact sink a shaft," say Harry Smedes, a respected field geologist formerly with the USGS who is now an adviser to the NWTS program leaders. "Knowing that the upper third of the formation has a lot of water-bearing beds in it, they feel that you have to drill an enormous borehole rather than use the conventional drill-and-blast, dig-it-out method where you've got men down in the hole. It's really pushing the state of the art. It depends on what drilling company you talk to as to how optimistic or pessimistic an answer you get."

The Nevada tuff. The investigation of Navada tuff—a rock formed not from the extrusion of lava flows but from the welding together of pumice, ash, and other material hurled out of volcanoes in explosive eruptions—is going on at Yucca Mountain, in an area that takes in the southwest corner of the Nevada Test Site and extends over onto other federally owned land. This location seems to have considerable potential as an area for disposal of radioactive waste. For one thing, the test site, which covers 1350 square miles, is already contaminated from three decades of nuclear weapons testing and presumably will be kept under tight institutional control for a long time to come. For another, some 1600 to 2000 feet of the tuff lies above the water table and this "unsaturated zone" may constitute an excellent geologic medium for radwaste disposal.

But some major technical issues have arisen in the Yucca Mountain investigation and remain unresolved. For instance, a potential earthquake problem came to light as the result of tests conducted only last spring. The tuff was found to be under high tensional tectonic stress—stress that tends to separate the rocks--and this makes existing faults in the area susceptible to movement in the event of a sizable earthquake in the larger region, which is seismically active.

From a technical standpoint this finding has not been considered particularly alarming; many mines have survived earthquakes, and, it is felt, a properly engineered Yucca Mountain repository could withstand such an event. Nonetheless, according to William W. Dudley, the USGS coordinator for the welded tuff investigation, the discovery that the probability of earthquake activity as the site is greater than was once believed, though perhaps not greater than 1 in 10,000 for any one year, created a stir among the project managers because of the regulatory and political problems that might be provoked.

DOE has reason enough to take such problems seriously, because, by some indicators, the Nevada political environment for radwaste disposal has changed from warmly receptive to coldly hostile. As recently as 1978 a radwaste repository was viewed by Nevada political leaders as possible economic boon. But during the last few years both Governor Robert List, a Republican, and the Democratic candidate who beat him in November, Attorney General Richard Bryan, have led a crusade to shut down a commercial low-level waste facility at Beatty, not far from the Nevada Test Site.

Why this change in the political climate? In an interview in early 1981, Governor List said, "It goes back to the atmospheric testing of the 1950's. The AEC misled the public. People don't trust the authorities. They are cynical. We have families who remember, survivors who litigate in the courts, high public awareness."

Salt beds and salt domes. A fundamental concern on the part of officials in the salt states—particularly Utah, Texas, and Mississippi—is that DOE has not stuck to what was to have been a sequential, step-by-step approach to site screening and selection. Instead, to keep from having to abandon its plan to select a salt site for an exploratory shaft this comming May, DOE has chosen to go to a dual-track approach. Construction of the exploratory shaft will proceed while at the same time the collection of hydrologic data continues—data on which originally the site's selection for full "characterization" was tc have in part been based.

For either bedded or dome salt the cost of constructing an exploratory shaft and doing the necessary in situ tests is expected to run somewhere between $30 million and $50 million. Thus, by going to this phase without adequate hydrologic data, DOE is gambling that the site will not be disqualified on the basis of information that comes in from test wells located around the site—information which could be gathered before the costly shaft is built if more time were allowed.

William Fisher, director of the Texas Bureau of Economic Geology, observes that something else besides money is being put at risk—DOE and the waste program's credibility. "I personally would prefer that they not take that risk," he says. According to Fisher, DOE has so little hydrologic data for the Palo Duro Basin, where a specific site remains to be pinpointed, that geohydrology cannot be used as a screening tool. Yet in and around the areas of interest there is, he says, some evidence within the formation of "interior dissolution."

In March 1981 the USGS advised DOE by letter that the chances for predicting subsurface geologic and hydrologic conditions were "significantly better in bedded salt than in dome salt." The basic reason for this, as indicated in the USGS letter, is that, while bedded salt formations can vary, they are in general characterized by a relatively simple "layer cake" geology of salt interbedded with other kinds of material and overlain by rocks from the erosion of surrcunding highland areas.

Salt domes, on the other hand, are far more complex. They were formed when deep layers of bedded salt, being relatively light and buoyant, pushed up through weak places in the overlying rock, rising thousands of feet until they approached the earth's surface, where characteristically the dissolving action of groundwater on the salt and the consolidation of less soluble materials has formed a caprock.

"A good way to visualize it," says Smede, "is to take a bunch of colored cloths or old rags and let each color represent a different rock type and have them stacked up like a layer cake, and then draw this entire mass up through a hole you've made by thumb and forefinger. You'll notice there are very complex vertically oriented folds, highly convoluted. Then if you snip part of that off and make a horizontal section, you'll see how complicated these crenulations are, largely vertically oriented but really like a marble cake. To the extent that these different rock types have desirable and undesirable hydrologic or mechanical properties, you can see the difficulty, the near impossibility, of trying to predict or determine ahead of time what the configuration is."

Complex as dome salt may be, all salt, as a generic rock type, presents complications because of the brine that it contains. The brine, as has been known since the 1960's, tends to migrate toward a heat source and, unless excessive temperatures are avoided, waste canisters could become immersed in a hot, highly corrosive bath.

For the most part the brine exists as microscopic "inclusions" in the salt. But it can also occur in large pockets, sometimes under pressure sufficient to blow out a well or create havoc in a mine. Twice now over the 8 years that DOE's Waste Isolation Pilot Plant (WIPP) project for military transuranic waste has been in progress near Carlsbad, New Mexico, drilling rigs have hit brine pockets.

The last time was November a year ago when DOE, acting at the insistence of state officials, sought to determine the nature of an anomaly that had been detected in a seismic survey near the north end of the proposed repository. Although not a show stopper, the discovery of this brine pocket, together with indications of some other irregularities or anomalies present at depth, led DOE to agree recently to a state recommendation to shift the repository's location, if the facility is to be built, from the north end of the site to the south end. Major brine pockets, incidentally, seem to be associated more with bedded salt than dome salt.

While salt beds are in general simpler than salt domes, DOE's investigation of the bedded salt of the Paradox Basin in Utah has not followed a happy or predictable course. Test boreholes have been drilled at four locations in the basin, and, unluckily, the best of them from a geologic standpoint has seemed to be a site in Davis Canyon within less than a mile of Canyonlands National Park.

Moreover, according to Robert J. Dingman, a consultant to the Utah state geologist, the most likely path for any radionuclide transport by groundwater is toward the park and the Colorado River. Collection of the relevant hydrologic data will require borehole drilling inside the park itself, Dingman believes. This requirement, if confirmed (DOE disputes Dingman's finding), could ignite further controversy about the exploration for radwaste disposal sites on the edge of a national park.

Last July, Utah's Governor Scott Matheson, disturbed at a DOE decision that the selection of a salt site for an exploratory shaft shall not be subject to a full environmental impact review, ordered state agencies to withhold all assistance from DOE, for example, denying permits for the transport of overweight drilling rigs on state roads. The effect has been to put the Paradox Basin investigation under a virtual moratorium.

Numerous scientific groups, in the United States and abroad, have concluded that the concept of the deep mined geologic repository for the disposal of radioactive waste is feasible. But the American experience to date in four rock types—basalt, tuff, and bedded and dome salt--shows that carrying out this concept is no simple, straightforward engineering task. A USGS official, testifying before a congressional committee last June, cautioned: "How successfully and quickly [the major geologic issues] can be resolved remains uncertain, in our opinion. Answers to many of the questions require innovative experimental procedures of large geometric dimension and long time periods."

Another authority, Paul A. Witherspoon, until recently head of earth sciences at the Lawrence Berkeley Laboratory and a leading expert on granite as a disposal medium, has proposed to DOE and the NRC, thus far unsuccessfully, that for every rock type and every candidate site a large-scale, 5- to 10-year experiment costing up to $39 million should be conducted to simulate the effect of heat from waste canisters on the rock mass.

According to Witherspoon, the experiment would serve mainly to influence repository design and the spacing of the waste packages but it might in some cases reveal a site to be unsafe and unacceptable. 'I've heard a lot of program managers say, "If we find a problem, we'll engineer around it.' That, in my opinion, is a very naive approach," Witherspoon told *Science*.

Despite all such cautionary advice from the experts, the cliché that "radioactive waste disposal is a political but not a technical problem" continues to be heard. It reflects a misapprehension of the realities of geologic disposal which is obviously quite widely held in Congress as well as in nuclear industry circles.

In 1970 the geologic disposal program suffered a political setback from which it has never fully recovered when the Atomic Energy Commission (AEC), acting precipitously, announced that the nation's first repository would be built in a salt mine at Lyons, Kansas. The proposal soon had to be withdrawn, for the site was shown to be ill-chosen and possibly unsafe. DOE is not likely to make, or to be allowed to make, mistakes as obvious as those the AEC made at Lyons. But unless the technical realities of geologic disposal are respected for what they are, with NWTS schedules adjusted as needed to fit those realities, further political embarrassments could well lie ahead.

WASTE BILL APPROVED

Finally reaching agreement in the waning days of the 97th Congress, the House and Senate on 20 December passed legislation that is intended to bring a federal-state accommodation on radioactive waste disposal.

The main barrier to final passage was lifted when Senator James McClure (R-Idaho), chairman of the Energy and Natural Resources Committee, yielded to the threat of a filibuster on an issue deemed of critical importance by potential repository host states. Their position was that, if a repository site selected for licensing application by the Department of Energy (DOE) and the President should be unacceptable to the host state, its "veto" of the site should stand unless overridden by both houses of Congress.

Although there was substantial congressional support for this position, the bills first passed by the House and the Senate had not gone that far, each body having chosen instead to give the host states a veto that would stand only if sustained by at least one house of Congress. But Senator William Proxmire, whose home state of Wisconsin contains granite formations that are of interest to DOE, was able to take advantage of the lateness of the hour by threatening to filibuster unless the state position was accepted.

McClure, as Senate manager of the legislation, chose to give in to Proxmire rather than see the legislation die, just as previous radwaste bill had died in 1980 at the close of the 96th Congress. This broke the impasse, with the Senate agreeing by voice vote to the bill with the more liberal state veto provision. Final passage in the House was by a vote of 256 to 32.

The concession made to the potential host states should give them strong leverage in their dealings with DOE whom some of the states (particularly Utah) have accused of failing to give them complete and timely information and of attempting to push the site selection process to rapidly.

But environmental lobbyists, citing what they perceive as important defects remaining in this long and complex piece of legislation, would have preferred to see the measure die. They found especially objectionable some procedural shortcuts on environmental review and a provision calling for DOE to present to Congress within 2½ years a site-specific proposal for a Monitored Retrievable Storage (MRS) facility for spent fuel or high-level waste. They see in the MRS the possibility that the goal of permanent disposal of radwaste might be abandoned. But nuclear industry lobbyists and DOE strongly favored passage of the legislation despite the major concession to states' rights. DOE has felt hamstrung for lack of the kind of satutorily defined federal-state "consultation and cooperation" mechanism that the legislation provides.

[Questions and responses are included in the appendix.]

Mr. LUNDINE. With respect to the monitored retrievable storage, does your analysis of the MRS technology suggest that it is sufficiently advanced to proceed with the development of a full-scale facility in 1985 as required by the act?

Mr. MORGAN. Yes, sir, we believe we have the technology in hand.

Mr. LUNDINE. Does your current analysis suggest that a stand-alone MRS facility is a particularly cost effective way to provide interim storage prior to disposal or reprocessing?

Mr. MORGAN. Since part of the law or the requirement for MRS is to perform the studies, we have done conceptual studies, but we haven't costed those out.

What we will present to Congress in 1985, as required by the act, is a detailed design with a cost. That report will give us the facility cost and the operating costs for that, and determinations could be made whether to proceed and whether it is cost effective.

There is some consideration that if you had an MRS and used it for a given period of time to allow the heat to dissipate from the fuel elements, you could space your fuel elements closer together if you were putting them in a repository after you had them in the MRS. You would do less mining and use less land, and that would be helpful on the costs.

We would have to evaluate that at that time.

Mr. LUNDINE. By that same time we would have adequate information about a T&E facility, so that we could make a judgment as to the comparative cost and other factors, should we want to review the question of whether one or the other or both make more sense?

Mr. MORGAN. That would be possible.

Mr. LUNDINE. Are there any further questions?

Earlier I had asked Dr. Brewer and Mr. Coffman whether you intended to utilize any of the solidified West Valley waste in the research and development repository program. Can you enlighten us on that subject?

Mr. LAWRENCE. No decision has been made on that yet. However, according to the act, we are allowed 100 cannisters, or 100 metric tons of either spent fuel or high level waste. It appears to us that the West Valley solidified waste would be the first commercial solidified waste available for such a demonstration.

Certainly that would be a very appropriate use for that material if it were available, but no final decision has been made. Otherwise, we would have to go with spent fuel.

Mr. LUNDINE. Thank you. I have no further questions.

If there are no further questions I would like to thank you very much.

The committee will continue its 1984 development authorization hearings on March 2, 1983 on nuclear waste management and nuclear fuel cycle research and development, non-Department of Energy witnesses.

This hearing is scheduled to begin at 9:30 a.m. in this room, 2325, Rayburn.

There was mention of a film. For those who would like to stay and see it, I wonder if we could have it shown in just a few minutes.

The hearing is now adjourned.

[Whereupon, at 10:32 a.m., the subcommittee was adjourned.]

APPENDIX

Department of Energy
Washington, D.C. 20585

April 25, 1983

Honorable Marilyn Lloyd Bouquard
Chairman
Subcommittee on Energy Research
  and Production
Committee on Science and Technology
House of Representatives
Washington, D.C. 20515

Dear Ms. Bouquard:

Following the February 24, 1983, hearing of the Science and Technology Subcommittee on Energy Research and Production on the DOE nuclear waste budget for Fiscal Year 1984, you sent some questions to Shelby Brewer and Robert Morgan.

Enclosed are the responses to the questions sent to Mr. Morgan and the responses to questions sent to Mr. Brewer on terminal isolation generic research and development and wastes systems technology. The responses to other questions addressed to Mr. Brewer were sent to you April 22.

If you have any questions, please call Diana Diamond or Tom Pretorius of my staff on 252-4277. They will be happy to assist you.

Sincerely,

Thomas H. Pretorius
for Robert G. Rabben
Assistant General Counsel
for Legislation

Enclosure

ADDITIONAL QUESTIONS FOR THE RECORD
MR. ROBERT MORGAN
FEBRUARY 24, 1983
HEARING BEFORE THE SUBCOMMITTEE ON ENERGY RESEARCH AND PRODUCTION

Nuclear Waste Fund

Repository

Please name all sites currently under consideration for a repository.

When during FY 1983 will the "third site" be identified?

Please explain what is included in the "waste package designs."

When will a decision be made on the "waste form" for high-level radioactive disposal materials? Will the Department accept spent fuel from utilities in an untreated form, that is, in the same condition as when removed from the reactor, or will some form of processing be required prior to acceptance by the Department?

Please identify all activities undertaken to date pursuant to the Nuclear Waste Policy Act of 1982.

The Committee had favored a co-located TEF in the context of H.R. 5016. When in FY 1983 will a decision be made on the siting for this facility?

What activities in the site characterization process for the repository may also be utilized to support a co-located and non co-located TEF?

How much additional funding, if any, will be needed in FY 1984 to fund activities for a co-located TEF and a non co-located TEF?

Please identify the percentage of the fund in FY 1984 which is to be used to support research and development activities.

Federal/State Assistance

What activities funded by the DOE involve cost-sharing by the States?

Program Management and Technical Support

Please identify and describe the Material Characterization Center (MCC). The Subcommittee is not at all familiar with this facility.

Please explain why the Climax Test Facility is being closed down in FY 1984 and why it is not considered useful in developing generic information on waste disposal.

Please explain the nature of the planned spent fuel storage at the E-MAD facility in Nevada.

Please provide an organization chart for the new Office of Civilian Waste Management.

QUESTIONS SUBMITTED BY THE
SUBCOMMITTEE ON ENERGY RESEARCH AND PRODUCTION
HOUSE COMMITTEE ON SCIENCE AND TECHNOLOGY

QUESTION: Please name all sites currently under consideration for a repository.

ANSWER: Sites currently under study for the Nation's first repository include the Richton and Cypress Creek salt domes in Perry County, Mississippi; Vacherie salt dome in Webster and Bienville Parishes, Louisiana; a bedded salt site either in Deaf Smith or Swisher County of the Texas Panhandle; a bedded salt site in either Davis or Lavender Canyon near Gibson Dome in San Juan County, Utah; a welded tuff site below Yucca Mountain on the western boundary of the Nevada Test Site, but also encompassing portions of Bureau of Land Management Land and Nellis Air Force Base, Nevada; and a site in basalt on the Department's Hanford site in southeast Washington State.

Studies are also being conducted for a second repository site in formations of crystalline rock such as granite. These formations being studied are in the following States: Michigan, Wisconsin, Rhode Island, Minnesota, Massachusetts, South Carolina, New Hampshire, Vermont, Maine, New Jersey, New York, Georgia, North Carolina, Maryland, Virginia, Pennsylvania and Connecticut.

QUESTION: When during FY 1983 will the "third site" be identified?

ANSWER: The Department plans to notify States of an intent to nominate a site within their boundaries during Spring 1983, so that early public input on issues related to the environmental assessments and site characterization plans (in accordance with provisions of the Nuclear Waste Policy Act) may be obtained in public hearings in the vicinity of the sites. Of the sites being considered, it is anticipated that three salt sites will be nominated after the siting guidelines are finalized in July. It is anticipated that the "third site", along with the sites at the Nevada Test Site and the Hanford Site, will be recommended for site characterization in late summer 1983.

QUESTION: Please explain what is included in the "waste package designs."

ANSWER: Waste package designs are being developed for site specific geologic media (salt, basalt, tuff) under consideration for the first repository. Each of these designs share the common feature of a multi-barrier material waste package (waste form, canister, overpack, backfill). Basically, either spent fuel or radioactive waste immobilized in a solid waste form will be encapsulated in a metallic cylindrical canister which in turn is placed in another sealed container referred to as the overpack. This overpack will then be emplaced in boreholes in the host rock of the repository. A backfill material comprised of crushed host rock material, or radionuclide sorbing material, or a combination of both, will be used to fill the annular space between the overpack and the borehole wall. Depending on the characteristics of the rock media, a support sleeve may be inserted between the borehole and the backfill material to maintain ease of retrievability.

Current activities related to waste package design include waste-form testing to determine radionuclide release rates, and materials development and testing to determine lifetime corrosion resistance to meet proposed regulatory requirements. In addition, waste package performance analyses and engineering trade-off studies are being conducted to aid in the waste package design process.

QUESTION: When will a decision be made on the "waste form" for high-level radioactive disposal materials? Will the Department accept spent fuel from utilities in an untreated form, that is, in the same condition as when removed from the reactor, or will some form of processing be required prior to acceptance by the Department?

ANSWER: With regard to the waste form for high-level radioactive waste, the Department identified in December 1982 a borosilicate glass composition as the reference waste form for defense high-level waste expected from the Defense Waste Processing Facility. The Department is in the process of establishing the capability of borosilicate glass as a commercial high-level waste (CHLW) form for meeting the repository waste acceptance criteria and proposed regulatory requirements. DOE plans to be in a position to make a decision on the CHLW form before the end of FY 1984. Regarding waste forms, the DOE decision process includes consultations with the Nuclear Regulatory Commission.

Aside from the transportation requirements placed on the shipment of spent fuel, the Department can accept spent fuel in the untreated form from the utilities. The plan is to receive the spent fuel in the as-is form and then disassemble and repackage the spent fuel in an overpack at the repository facility in order to meet the waste acceptance specifications for emplacement.

QUESTION: Please identify all activities undertaken to date pursuant to the Nuclear Waste Policy Act of 1982.

ANSWER: In anticipation of the Act being passed, the Department began work related to a nuclear waste bill as early as January 1982. At that time, a special Nuclear Waste Task Force was established.

Shortly after passage of the Act in January 1983, Robert L. Morgan was named Project Director of the Nuclear Waste Policy Act Project Office, and charged with implementing the near-term requirements of the Act, as well as management of activities until the Office of Civilian Radioactive Waste Management is established and a Director is nominated and confirmed.

Experienced staff from the existing Nuclear Waste Management Program as well as from the Department's Office of Policy, Planning and Analysis were detailed to the Project Office.

The Act requires multifaceted milestones be met, especially during the first six-to-nine months after passage. Some of those milestones have already been met; they include:

o The Department published in the Federal Register on February 4, 1983, a Draft Contract for disposal of spent nuclear fuel and high level waste.

- The Department held a public hearing on the proposed Draft Contract on March 3, 1983.
- Written comments on the Draft Contract have been received from approximately 50 utilities and these comments are currently being evaluated.
- The Department published proposed Repository Siting Guidelines in the Federal Register on February 7, 1983.
- The Department has identified six States having potentially acceptable sites for the first repository, and on February 2, 1983, the Secretary notified the Governors of those States. The States are: Washington, Nevada, Utah, Texas, Mississippi and Louisiana.
- The Department also sent letters on February 10, 1983, to the Governors of 17 States informing them that DOE will conduct more detailed research to determine if their States could potentially be acceptable as a second respository site. They were: Wisconsin, Michigan, Rhode Island, Minnesota, Massachusetts, South Carolina, New Hampshire, Vermont, Maine, New Jersey, New York, Georgia, North Carolina, Maryland, Virginia, Pennsylvania and Connecticut.
- During March 1983, the Department held Public Hearings in Chicago, New Orleans, Washington, D.C., Salt Lake City, and Seattle to receive written and oral testimony on the proposed siting guidelines.

- During February and March discussions and meetings have been held in a number of the States notified as having potentially acceptable sites for the first repository and those States notified as having rock formations of interest for the second repository.
- Public Hearings were held in late March at the Hanford site, Washington, and Nevada site to inform residents of these areas of the proposal to nominate these sites for characterization studies and to solicit and receive recommendations from these residents with respect to issues that should be addressed in the environmental assessments and site characterization plans.
- A meeting of all 17 crystalline States was held in Chicago on February 10, 1983, to discuss implementation of the Act and the plans for a second repository siting program in crystalline rock.

QUESTION: The Committee had favored a co-located TEF in the context of H.R. 5016. When in FY 1983 will a decision be made on the siting for this facility?

ANSWER: Public Law 97-425 requires that a report be submitted to Congress not later than one year from enactment (1/7/84) discussing DOE's plan for location of the TEF. The Department is currently evaluating issues associated with the TEF such as siting. Since resolution of these issues will require extensive interaction with DOE, and with other Federal agencies, State governments and the Office of Management and Budget, it is not known at this time, when final decisions will be available.

QUESTION: What activities in the site characterization process for the repository may also be utilized to support a co-located and non co-located TEF?

ANSWER: A co-located TEF will utilize all the data derived from the site characterization process to support its design and construction effort, as well as to influence the particular tests to be run in the TEF test program. The amount of site characterization data that can be utilized in a non co-located TEF will vary, depending on its media and precise location.

QUESTION: How much additional funding, if any, will be needed in FY 1984 to fund activities for a co-located TEF and a non co-located TEF?

ANSWER: The FY 1984 Presidential budget request under the Nuclear Waste Fund contains no funding for a TEF. The Department has not yet determined the specific amount of additional funding required to support TEF, either co-located or not.

QUESTION: Please identify the percentage of the fund in FY 1984 which is to be used to support research and development activities.

ANSWER: In 1984, the Commercial Nuclear Waste program authorized by the Nuclear Waste Policy Act of 1982 begins a transition from the research phase to the engineering development phase. A major portion of the work is in the engineering development and scientific testing mode. Only a small portion can be characterized as applied research, such as, waste package design and materials characterization.

QUESTION: What activities funded by the DOE involve cost-sharing by the States?

ANSWER: None of the activities funded by DOE involve cost-sharing agreements with the States. The States receive grants from DOE to review information, data and results from the ongoing repository siting investigations. The requested FY 1984 Federal/State Impact Assistance funds will be used primarily to assist the States where siting investigations for the first repository are more advanced. These States will include Washington, Nevada and a third State where a candidate salt site is to be selected later in FY 1983.

QUESTION: Please identify and describe the Materials Characterization Center (MCC). The Subcommittee is not at all familiar with this facility.

ANSWER: The Materials Characterization Center (MCC) is a group of materials scientists in Battelle's Pacific Northwest Laboratory, Richland, Washington, who have been asked to develop testing methods for Waste Package materials and to publish a data handbook containing carefully acquired laboratory data on the performance of the waste package under repository-type conditions. The MCC provides the test basis for comparing waste forms and for predicting the long-term stability of the waste package. It coordinates the interests of the potential producer of solidified waste with the interests of the developer and operator of a repository for mined geologic disposal. In particular, it provides the testing bases by which proof of performance can be derived for licensing of the repository by the Nuclear Regulatory Commission for disposal of specific packages of waste containing solidified waste forms.

QUESTION: Please explain why the Climax Test Facility is being closed down in FY 1984 and why it is not considered useful in developing generic information on waste disposal.

ANSWER: The planned tests for the Climax Test Facility have essentially been completed. The only technical activities which remain are the removal and examination of the spent fuel and data collection during the cool-down period in the facility. This work would provide the Department with all the generic information on waste disposal which was to be produced in the Climax test. The Climax Facility may still be available for occasional tours or other uses as may be identified by the Department. The Department's Crystalline Program is currently considering the possibility that the Climax Facility could be used for some tests in support of that program.

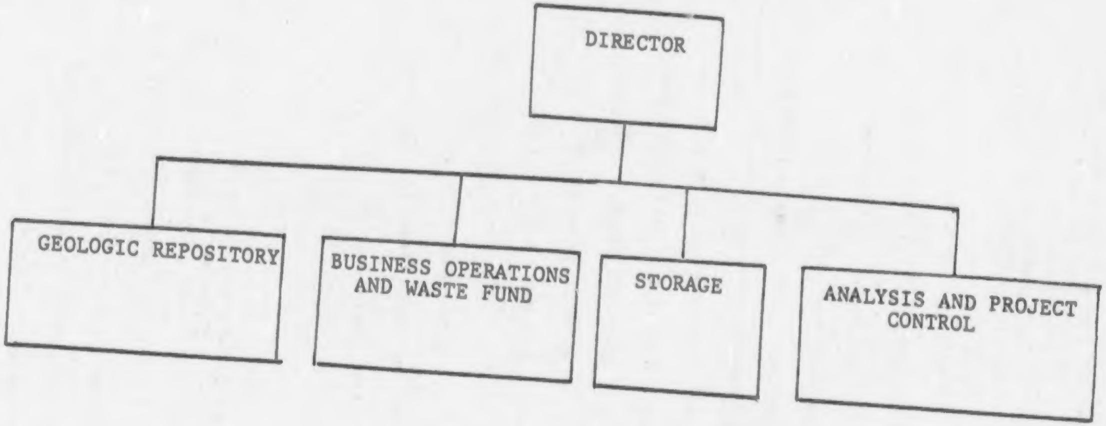
QUESTION: Please explain the nature of the planned spent fuel storage at the E-MAD facility in Nevada.

ANSWER: The E-MAD facility will be used to store the spent fuel which will be removed from the Climax Facility in FY 1983. In addition, the fuel currently in storage at E-MAD will remain there. There are no firm plans at this time to use the E-MAD facility for Federal storage activities, however, the Department is considering the use of E-MAD joint unlicensed demonstrations to be proposed by utilities as provided for by the Act.

QUESTION: Please provide an organization chart for the new Office of Civilian Waste Management.

ANSWER: We are currently working with Management and Administration to develop budget, program and manpower plans for activities mandated by and associated with the Nuclear Waste Policy Act. The temporary Project Office has been set up by general functional areas -- Geologic Repository; Storage; Business Operations and Waste Fund; and Analysis and Project Control. While this kind of overall organizational and functional grouping may be considered in structuring of the permanent office, we do not at this time have an organization chart for the Office of Civilian Radioactive Waste Management. It would be our hope that a Director will be named shortly and that he or she will participate in the final determination of the organizational structure for the permanent office. In the meantime, I have attached for your information an organization chart on the temporary Project Office.

NUCLEAR WASTE POLICY ACT PROJECT OFFICE


DIRECTOR
GEOLOGIC REPOSITORY
BUSINESS OPERATIONS AND WASTE FUND
STORAGE
ANALYSIS AND PROJECT CONTROL

ATTACHMENT 1

QUESTION:	Please comment on all of the concerns expressed in the January 7, 1983, article in "Science," "The Radwaste Paradox," regarding repository development at Hanford, in Nevada, and at the various bedded salt and salt dome sites (article attached).
ANSWER:	I have read the article and I have met recently with the author. It is my understanding that when Mr. Carter was developing the article, he met with and discussed his concerns with DOE program personnel involved in the nuclear waste program.

I agree with the premise of the article that technically speaking, "you can't appreciate the problems until you get there." However, I believe Mr. Carter would agree with me that we must get there; we must provide for permanent disposal of high-level nuclear waste. I believe that we now have the framework for site selection and for the technical, political and programmatic processes which will lead to the operation of the first repository in 1998.

As I have testified before the House Subcommittee on Energy Conservation and Power, the Department has a commitment not to sacrifice technical quality and reliability for schedule purposes. While I believe that this country does have the technology to proceed with development of permanent waste disposal, engineering and scientific testing and site characterization activities will receive the maximum technical and public participation and review prior to site selection.

ADDITIONAL QUESTIONS FOR THE RECORD
DR. SHELBY T. BREWER
FEBRUARY 24, 1983
HEARING BEFORE THE SUBCOMMITTEE ON ENERGY RESEARCH AND PRODUCTION

(Quotations are to the Congressional Budget Request, FY 1984)

General

Please provide a written transcript of the film shown at the hearing.

Terminal Isolation Generic R&D

Please specify what is meant by "All other generic R&D will be completed in FY 1983." What are these activities that will be completed?

Please describe the "research cruises," and "in-situ heat transfer experiments" relative to subseabed disposal and identify the participating countries and their respective share of these activities.

Please explain and describe the activities conducted at the Stripa mine in Sweden, at the Asse mine in the FRG, and at the undesignated site in Canada and describe the nature of the U.S. participation.

Please explain why the U.S. must take the lead in the design of "free fall boosted pentrometer tests and an in-situ heat transfer experiment" relative to subseabed disposal R&D.

Waste Systems Technology

Please explain what activities will be undertaken in FY 1983 and beyond in the "expanded program" relative to the Nuclear Energy Agency (a part of the Organization for Economic Cooperation and Development), and if the conduct of these activities was prompted by the enactment of P.L. 97-425 as stated. Please identify the section of this Act that requires or permits such activities.

Low-Level Waste

Please specify the anticipated areas of improvement in LLW "practices, technique and procedures" that will be investigated and developed.

Please identify and explain what "cooperative technology development demonstrations with the States and industry" are expected in FY 1984.

Please specify how much of the requested funding will be provided to the States, identify the expected recipient States and their share of funding, and briefly explain the conditions applicable to the States in receiving and spending such sums.

QUESTIONS SUBMITTED BY THE
SUBCOMMITTEE ON ENERGY RESEARCH AND PRODUCTION
HOUSE COMMITTEE ON SCIENCE AND TECHNOLOGY

QUESTION: Please specify what is meant by "All other generic R&D will be completed in FY 1983." What are these activities that will be completed?

ANSWER: In FY 1983, and prior to enactment of the Nuclear Waste Policy Act of 1982, the Commercial Waste Management activities included five activities -- one of which was terminal isolation generic R&D. Although this was generic R&D as opposed to media-specific, most of this work directly supports the development and licensing of the first geologic repository. FY 1983 terminal isolation generic R&D includes development of measurement methods for laboratory testing of host rocks and the radionuclide migration through rocks; development of an integrated generic performance assessment model to predict potential release and migration rates from a repository; definition of preliminary waste acceptance criteria and specifications; development and testing of repository sealing and backfill systems; development and testing of equipment and instrumentation for in situ testing and performance monitoring; and a technical status report on the critical feasibility issues for the subseabed disposal concept. In FY 1984, the generic R&D activities will include only subseabed. The other activities referred to here will be completed in FY 1983 and are the activities we refer to in the FY 1984 budget as, "all other generic R&D will be completed in FY 1983."

QUESTION: Please describe the "research cruises," and "in-situ heat transfer experiments" relative to subseabed disposal and identify the participating countries and their respective share of these activities.

ANSWER: Under the NEA Seabed Working Group, eight countries and the Commission of European Communities (CEC) are conducting independently-funded programs to assess Subseabed Disposal, while coordinating the total research and development program. The program includes research cruises and an In-Situ Heat Transfer Experiment (ISHTE).

Research cruises are trips to study areas for prospective subseabed disposal sites through the collection of data and samples for further analysis. The studies can be for biological, physical, geological or geophysical purposes. At least six trips to each study area are needed to characterize a site. In the North Pacific four of the six site cruises have been completed on three sites, with two of the sites showing very high promise. In the Atlantic two of the six cruises have been completed on four study locations. In the Pacific no further cruises are planned at this time. In the Atlantic during the next two years, four cruises will go to each of the four sites. All of the Atlantic cruises will be funded by the other countries (Canada, France, Netherlands, and the United Kingdom).

The ISHTE is a one-year multi-purpose experiment to confirm the capabilities, and effects of heat transfer on deep sea sediment. The U.S. will continue to take the lead in the design, fabrication and testing of the ISHTE components. If the ISHTE is fielded at a North Atlantic site, other countries may provide the ships required for its deployment and recovery, and will test the actual subseabed sediments.

QUESTION: Please explain and describe the activities conducted at the Stripa mine in Sweden, at the Asse mine in the FRG, and at the undesignated site in Canada and describe the nature of the U.S. participation.

ANSWER: Under the auspices of the NEA/OECD, the United States has jointly funded work in the Stripa mine in Sweden along with Sweden, Canada, Finland, France, Japan, Switzerland and the United Kingdom. Stripa is a depleted iron ore mine in granite which is used only for research on the technology for waste disposal. No waste has been or is being disposed of there nor is radioactive waste being used for experiments.

The experiments have permitted studies of the flow of water through granite, the effects of massive clay backfilling of the tunnels and the behavior of migration of chemicals through fractured granite. All of these must be understood to license and assure the safety of a repository. Additional experiments are being started in FY 1983 to: (1) test the effectiveness of instruments in measuring the fracture characteristics of the rock between two boreholes; (2) test the migration of chemicals in three dimensions as an aid in mathematical modeling; (3) test the effectiveness of sealing techniques; and, (4) test flow through fractures by use of radioactive tracers. The U.S. will provide 17.5% of the funds, or approximately $1.5 million out of a total of $8.57 million, for about 4 years of experiments.

Asse salt mine is being used by the FRG for waste management experiments in salt. It was previously used by the FRG for low-level waste disposal. Under a bilateral agreement between the U.S. and the FRG and a specific project agreement with the FRG, the FRG will conduct experiments to test the physical and chemical behavior of salt under intense radiation and heat. This will validate mathematical models of such phenomena as migration of moisture towards the waste package. The Asse experiments are starting this year. By agreement, DOE has supplied the test equipment from the U.S. and the FRG will install and operate the equipment. No exchange of funds will be made. The U.S. will receive the test results in about three years.

Under a Bilateral Agreement with the Atomic Energy of Canada, Limited (AECL), DOE has been cooperating with Canada on the planning and initial testing for a possible underground research laboratory near the AECL Whiteshell Facility, Pinawa, Canada. To date our cooperation has been in the form of exchanging information with AECL and technical consultation. The course of future participation will depend on the type of experiments which can be carried out. This will be decided in future negotiations with AECL.

QUESTION: Please explain what activities will be undertaken in FY 1983 and beyond in the "expanded program" relative to the Nuclear Energy Agency (a part of the Organization for Economic Cooperation and Development), and if the conduct of these activities was promoted by the enactment of P.L. 97-425, as stated. Please identify the section of this Act that requires or permits such activities.

ANSWER: The OECD/NEA has been active for several years in coordinating the following waste management activities: (1) joint sponsorship of Stripa experiments; (2) joint sponsorship of the development of an international data bank on geologic disposal; (3) general technical exchange through international workshops and technical documentation; and, (4) shared investigations of subseabed as a possible disposal method for nuclear waste. Because of the intense interest on the part of many countries, the NEA role is becoming increasingly important, with more activities to foster and guide the activities of participating countries.

The expanded program of the NEA has not been completely defined for 1983, but it is expected to emphasize technical and economic studies in the fuel cycle area. It may also include probablistic risk assessment studies in the areas of waste management and reactor safety. DOE participates in these NEA waste management projects pursuant to our general authority to engage in international agreements for cooperative R&D projects.

International cooperation is also encouraged by Section 223 of the Act (P.L. 97-425) which specifically states that it shall be the policy of the United States to cooperate with and provide technical assistance to non-nuclear weapon States in the field of spent fuel storage and disposal. On March 30, 1983, a joint DOE/NRC Notice was published in the Federal Register to announce and summarize the international cooperation and technical assistance that will be made available.

Department of Energy
Washington, D.C. 20585

April 22, 1983

Honorable Marilyn Lloyd Bouquard
Chairman
Subcommittee on Energy Research
and Production
Committee on Science and Technology
House of Representatives
Washington, D.C. 20515

Dear Ms. Bouquard:

Following the hearing of the Science and Technology Subcommittee on Energy Research and Production held February 24, 1983, on the authorization of DOE nuclear waste program, you sent Shelby Brewer some questions. Enclosed are responses to most of those questions. Robert Morgan is preparing answers to the questions concerning Terminal Isolation Generic R&D and Waste Systems Technology.

If you have any questions, please call Diana Diamond or Tom Pretorius of my staff on 252-4277. They will be happy to assist you.

Sincerely,

Thomas H. Pretorius

for Robert G. Rabben
Assistant General Counsel
for Legislation

Enclosure

Department of Energy
Washington, D.C. 20585

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Robert G. Rabben
Assistant General Counsel
for Legislation

Enclosure

bcc: Ms. Julie Shisler
Subcommittee Staff

ADDITIONAL QUESTIONS FOR THE RECORD
DR. SHELBY T. BREWER
FEBRUARY 24, 1983
HEARING BEFORE THE SUBCOMMITTEE ON ENERGY RESEARCH AND PRODUCTION

(Quotations are to the Congressional Budget Request, FY 1984)

General

Please provide a written transcript of the film shown at the hearing.

Terminal Isolation Generic R&D

Please specify what is meant by "All other generic R&D will be completed in FY 1983." What are these activities that will be completed?

Please describe the "research cruises," and "in-situ heat transfer experiments" relative to subseabed disposal and identify the participating countries and their respective share of these activities.

Please explain and describe the activities conducted at the Stripa mine in Sweden, at the Asse mine in the FRG, and at the undesignated site in Canada and describe the nature of the U.S. participation.

Please explain why the U.S. must take the lead in the design of "free fall boosted pentrometer tests and an in-situ heat transfer experiment" relative to subseabed disposal R&D.

Waste Systems Technology

Please explain what activities will be undertaken in FY 1983 and beyond in the "expanded program" relative to the Nuclear Energy Agency (a part of the Organization for Economic Cooperation and Development), and if the conduct of these activities was prompted by the enactment of P.L. 97-425 as stated. Please identify the section of this Act that requires or permits such activities.

Low-Level Waste

Please specify the anticipated areas of improvement in LLW "practices, technique and procedures" that will be investigated and developed.

Please identify and explain what "cooperative technology development demonstrations with the States and Industry" are expected in FY 1984.

Please specify how much of the requested funding will be provided to the States, identify the expected recipient States and their share of funding, and briefly explain the conditions applicable to the States in receiving and spending such sums.

Please describe and identify sites for the additional LLW demonstrations expected to be conducted.

Please explain why it is necessary for DOE to purchase a "computer base tracking" system for LLW when the responsibility for disposal rests with the States and NRC.

III. Remedial Action

FUSRAP

Please describe what actions are necessary to clean-up the W.R. Grace site in New Jersey and identify the funding level that would be required to accomplish this work. Please identify the funding level that would be required to remove all contaminated material from this site and transport it to a low-level waste disposal site.

Surplus Facilities

Please list the 100 civilian R&D facilities scheduled for decontamination under this program and specify the funding required for each facility.

West Valley Demonstration Project

Please explain whether the project is scheduled to be completed on an "as soon as is practical" basis or on some other basis. If some other basis is used (such as the availability of disposal facilities), please justify the choice and explain whether this basis minimizes the costs to the government.

Please explain whether it is more expensive for the government to decontaminate and use existing facilities or to build new facilities adjacent to existing facilities.

Please explain whether the new waste solidification facilities at West Valley will be of a modular design so that they may be disassembled and used elsewhere at the completion of the West Valley Project and, if not, why not?

Please identify the amount of funding to be provided by the State of New York in FY 1984 and beyond and specify whether it is in-kind or cash funding.

What fraction of the FY 1984 funding for this Project will be used to decontaminate existing facilities at the site?

TRANSCRIPT

WEST VALLEY DEMONSTRATION PROJECT 1982 ACCOMPLISHMENTS VIDEOTAPE

From 1966 to 1972, this facility, located near West Valley, New York, reprocessed nuclear fuel.

As a byproduct, almost 600,000 gallons of liquid, highly radioactive, nuclear waste remain, stored below ground in a carbon steel tank.

In 1980, the United States Congress passed the West Valley Demonstration Act, which directs the Department of Energy to solidify the liquid waste so that it can be transported to a federal repository for disposal.

In addition to enhancing the local environment, the successful solidification of nuclear waste here will help demonstrate that the United States can safely and responsibly manage its high level nuclear waste.

On February 25, 1982, the Department of Energy assumed control of the former reprocessing facility, allowing the nuclear waste management project to begin.

The environmental impacts of the West Valley Demonstration Project have been thoroughly reviewed. The Final Environmental Impact Statement, which was issued in 1982, concludes that solidifying the stored nuclear wastes can be done safely, enhancing rather than threatening the local environment.

In 1983, the Department of Energy will select the durable solid into which the liquid wastes will be converted. Borosilicate glass, the most likely candidate, has the same durable properties of pyrex glassware. When radioactive waste is blended with molten borosilicate glass and poured into steel containers, it hardens into a non-dissolvable solid.

The carbon steel tank which holds the liquid nuclear waste at West Valley was inspected in 1982 to insure its integrity until the liquid can be removed for solidification.

Test results confirm that the tank's half-inch thick, plate steel walls are in good shape, providing safe interim storage for the radioactive liquid.

Close inspection of this scale model of the West Valley steel storage tank reveals a complicated internal grid structure in the tank's base. The solids in the nuclear waste have settled into this internal grid structure, leaving a clear yellowish liquid in the upper portion of the tank.

Project engineers lowered a special instrument to the bottom of the tank to characterize the consistency of the settled waste sludge. Special pumps are being developed at the Department of Energy's Savannah River Laboratory, When inserted into the tank, these pumps can stir up the clay-like material on the bottom so that it can be removed for solidification.

By sampling the liquid in the tank, detailed chemical and radiological analyses have determined the exact composition of the nuclear waste.

Based on these results, engineers chemically simulated the West Valley waste at the Department of Energy's Pacific Northwest Laboratory in Hanford, Washington. The simulated waste was then combined with molten borosilicate glass and poured into a steel container. The 7 feet high, 2 feet in diameter, solid cylinder adds confidence that the West Valley wastes can be safely solidified.

QUESTIONS SUBMITTED BY CONGRESSWOMAN MARILYN LLOYD BOUQUARD

Low Level Waste

QUESTION 1: Please specify the anticipated area of improvement in LLW "practices, techniques, and procedures" that will be investigated and developed.

ANSWER:

a. For volume reduction, continued assistance will be provided to help waste generators bring incineration into practice. The activity will include studies to facilitate licensing by NRC by supporting generators that are taking such initiatives. Improved efficiency in the treatment of liquid waste will also be explored to reduce disposal site space and to reduce overall costs. A new technique will be tested during FY 1983 and FY 1984.

b. New disposal trench designs will be required in portions of the eastern United States. The effort will involve new materials, new designs, and new disposal practices. One new practice may be the use of a natural zeolite for trench liners, allowing the water to pass through but retaining the radioactivity within the trench. Testing of this will be done in FY 1984.

c. Current disposal sites need stabilization in order to be properly closed. Two techniques--grouting and dynamic compaction--will be tested in FY 1983 and FY 1984 and applied in FY 1984. These techniques may be of major value to eastern sites or four of the six commercial sites.

d. New geophysical techniques may be needed to characterize disposal sites, particularly the more geologically complex sites. Additionally, some records of older sites are so poor that all of the trenches cannot be located. A new technique called tomography will be tested. This technique has the potential to yield a three-dimensional picture of the subsurface conditions. Other techniques will be tested when they are identified.

e. The program has been working cooperatively with NRC, EPA, and USGS to establish methods to evaluate and validate site performance models. This joint effort will continue.

f. Waste form is a potential area for achieving improved performance. The difficulty is that the current state of knowledge is too limited to permit understanding or prediction of long term performance. Thus, waste form requirements would exact premature costs without the certainty of providing known benefits. To overcome this, it is intended, by experimental and theoretical approaches, to examine the behavior of waste forms over the long term as a basis for subsequent decisions.

QUESTION 2: Please identify and explain what "cooperative technology development demonstrations with the States and industry" are expected in FY 84.

ANSWER: There are four. These are as follows:

a. Application of portable incineration at multiple reactor stations of a single utility. Four stations and seven reactors will be involved.

b. Stabilization of an existing disposal site in cooperation with the site owner, a State, and the various contractors.

c. Demonstration of a new volume reduction system for liquid reactor wastes.

d. Site characterization at new disposal sites demonstrating some new techniques.

QUESTION 3: Please specify how much of the requested funding will be provided to the States, identify the expected recipient States and their share of funding, and briefly explain the conditions applicable to the States in receiving and spending such funds.

ANSWER: It is not possible now to predict exactly which specific States will request assistance from the Department and how much will be requested. About $2 to $3 million has been provided in past years in support of the development of a commercial waste management system. This is expected to be the regional level of support in future years. Support for States are provided by grants. All grants include specified deliverable products and reporting requirements. Only minor restrictions are imposed on the States, allowing normal State practices to be followed. In all cases, the projects will be cost shared with the States. The State share in grants awarded to date has been at least 25 percent. In FY 1984 and outyears, projects anticipated are as follows:

a. Colorado should receive about $0.5 million to help in the development of a disposal site. The State will commit resources of about $0.2 million. A series of deliverable products will be specified in the grant with the State responsible for achieving these deliverables. The study expected is an examination of the options available to the State to generate the resources needed to support the low-level waste management activities without continued Federal support.

b. Illinois has indicated that support will be requested to assist in locating a new disposal site. It is possible that another State will volunteer to host a disposal facility in the midwest and request similar assistance. The order of magnitude is estimated to be $0.5 million. The exact scope of work is not known.

c. Kentucky may request assistance in stabilizing the Maxey Flats disposal site. This could involve measures to reduce or mitigate the subsidence at the site. The results of the tests and demonstrations will be published for use by others. This may cost $1 to $2 million.

d. The Western Governors Policy Office, with support from the Southern States Energy Board, is proposing to implement the first stage of an information management system. This system would acquire the data that States need to support decisionmaking and routinely continue to acquire the data. This may cost $1.3 million.

e. It is likely that two States will request support in locating disposal sites in the Northeast. Currently, siting processes are being developed in Pennsylvania and Massachusetts. Continuation may involve $1 million.

f. The Central States have indicated that support will be requested to screen all member States to identify areas suitable for disposal sites. The suitable areas will be documented and made known to private industry. This may involve $0.5 million.

g. California is attempting to obtain the proper waste management facilities. During FY 1984, a location for a disposal site will be sought, and there are indications Federal assistance is needed. It is estimated that $0.5 million will be involved.

h. Some small States seem to be exploring the single state approach; Maine is one such State. These States may request Federal assistance. DOE has not supported such studies in the past.

QUESTION 4: Please describe and identify sites for additional LLW demonstrations expected to be conducted.

ANSWER: We expect to do additional LLW demonstrations in cooperation with States and private industry in several technical areas at various facility locations. The technology requiring demonstration has been identified and is listed below. Specific locations, except for the Maxey Flats, Kentucky, demonstration, have not been determined. Location will depend upon the State or private concern joining DOE in conducting the demonstration.

a. Incineration at boiling water reactors and pressurized water reactors.

b. Maxey Flats disposal site: a closed low-level waste disposal site in need of stabilization and closure.

c. Potential new disposal sites needing characterization, especially east of the Mississippi River.

d. Other new, cost effective volume reduction techniques for power generating reactor plants.

QUESTION 5: Please explain why it is necessary for DOE to purchase a "computer base tracking" system for LLW when responsibility for disposal rests with the States and NRC.

ANSWER: In order to better understand the low-level radioactive waste management system in the United States, the program conducted an analysis of the country's waste management system during FY 1980. This analysis described the flow of low-level radioactive waste from generator to disposal site and detailed the information available on the waste at each step between the generators and the disposal sites. The type of information, waste volume, radioactivity, physical characterics, etc., and the level of detail, per waste stream, per package, by specific radionuclides, etc., were inconsistent between generators, waste streams, and points in the flow of waste from generators to disposal sites. Information requests from various States and Federal agencies, as well as organizations and individuals, led to the establishment of a computer information management system during FY 1981.

The role of the DOE Low-Level Radioactive Waste Management Program has been to lease access to a computerized data base system to function as the centralized repository for the information gathered from and by the States and other Federal agencies and to develop and use programs which process this information and make it available to all States to support their decisionmaking. The information also assists DOE in facilitating the creation of an operational State-run, regional low-level waste disposal system. The proposed work for FY 1984 and beyond would be the next step; namely, to expand the data base into several regions, thereby making it a national system. States continue to express a desire to better understand their low-level radioactive waste management situation.

The amount of data makes a computer system functionally valuable, and the body of experience of other States with the DOE system has established a precedent for good results. The DOE system supports the sharing of the information gathered by the States among States and the Federal Government. Planning and decision-making at the Federal level is greatly enhanced by such a system.

Remedial Action

FUSRAP

QUESTION 1: Please describe what actions are necessary to clean up the W. R. Grace site in New Jersey and identify the funding level that would be required to accomplish this work. Please identify the funding level that would be required to remove all contaminated material from this site and transport it to a low-level waste disposal site.

ANSWER: This formerly licensed site is not designated by DOE for remedial action, and DOE does not have legislative authority for remedial action if such action is needed. The Nuclear Regulatory Commission (NRC) is reviewing the need for remedial action and the means to accomplish the action. DOE will, however, provide an evaluation and estimate of costs to the subcommittee as requested.

The NRC guideline, "Disposal of On-Site Storage of Thorium or Uranium from Past Operations," (Federal Register, Volume 205, page 52661, October 23, 1981) was used as a guideline for determining cleanup actions, together with the radiological survey performed by the Oak Ridge Associated Universities for the NRC reported in January 1983. On this basis, our preliminary evaluation is that areas off the site needing cleanup and consolidation of the waste onsite are the following: areas along Sheffield Brook that were contaminated by discharge from the waste treatment system; the school bus maintenance yard south of the site; and a section of track and right-of-way on the Erie Lackawanna Railroad that was formerly used for unloading materials. A preliminary estimate is that about 1800 cubic meters would have to be excavated and consolidated onsite. One alternative is that this material and other surface and subsurface contamination would be stabilized onsite. The actions to achieve adequate stabilization need to be studied before providing a cost estimate. If the site were decontaminated in accordance with the NRC guidelines, a preliminary estimate is that 10,000 square meters of the site area would have to be decontaminated, resulting in about 40,000 cubic meters of waste to be transported and disposed elsewhere. We do not have estimates of the costs for the offsite cleanup, the onsite stabilization, or the decontamination of the site. We will obtain preliminary estimates of these costs in the next few weeks.

Remedial Action

Surplus Facilities

QUESTION 1: Please list the 100 civilian R&D facilities scheduled for decontamination under this program and specify the funding required for each facility.

ANSWER: A list of the civilian R&D facilities and an estimate of funding required are provided for the record. There are 55 facilities currently listed as part of the Surplus Facilities Management Program which will require decommissioning in the future. This list has recently been reduced in number by grouping several similar items into a "facility." A list of 18 facilities that have been decommissioned in the past is also provided for the record.

The cost estimates are in year-of-expenditure dollars; that is, they include inflation and are thus schedule dependent. The current planning schedule for the program is provided.

Earlier cost estimates for decommissioning of these facilities were based on the assumption that all facilities would be decommissioned to unrestricted release levels. This assumption is needlessly restrictive and would result in unwarranted cost to the Government.

For this reason, DOE is performing long-range planning during FY 1983 and FY 1984 the purpose of which is to reduce decommissioning costs to as low as practicable while still providing the needed long-term radiological control. During FY 1983 and FY 1984, detailed radiological surveys will be performed at each site to provide the basis for risk assessment. Reusable facilities, equipment, and materials will also be identified. Cost estimates for decommissioning the facilities will then be determined based on hazards analysis and the level of control needed to protect the public from the real hazards.

Updated decommissioning cost estimates for the program's facilities will be available early in FY 1985.

SURPLUS FACILITIES MANAGEMENT PROGRAM (SFMP)
INVENTORY OF PROJECTS/FACILITIES

FIELD OFFICE AND PROJECT	F.O. PRIORITY	FACILITIES	TOTAL ESTIMATED COST ($ IN THOUSANDS)
Albuquerque			
Mound ANSPD Areas Decommissioning	1	PP Building R Building Waste Transfer Sys. & Bldg. 41	$33,740
TA-35 LAPRE II Reactor Vessel Decom.	2	TA-35 LAPRE II Reactor Vessel	TBD*
TA-2 Water Boiler Reactor Decom.	3	TA-2 Water Boiler Reactor	1,500
TA-52 UHTREX Facility Decom.	4	TA-52 UHTREX Facility	1,500
Chicago			
Building 350 (Pu Gloveboxes) Decom.	1	Building 350 (Pu Gloveboxes)	2,393
ANL-East Surplus Facilities Decom.	2	Hot Machine Shop - Building 17 Fan House No. 1 - Building 37 Fan House No. 2 - Building 38 Pangborn Dust Collect. - Building 41 Ind. Waste Treat Plant - Building 34 R/A Mat. Storage Vault - Building 16F	2,510
Juggernaut Reactor Decom.	3	Juggernaut Reactor	TBD*
EBWR Facility Decom.	4	Experimental BWR Facility	TBD*
Idaho			
Monticello Site Remedial Action	1	Monticello Site	TBD*
SPERT & BORAX Ancillaries Remedial Action	2	SPERT I Facility SPERT I Facility Ancillaries SPERT II Facility Ancillaries SPERT III Facility Ancillaries SPERT IV Facility Ancillaries BORAX V Facility Ancillaries	360
BORAX V Facility Decom.	3	BORAX V Facility	1,750

*Project cost estimate to be determined.

SURPLUS FACILITIES MANAGEMENT PROGRAM (SFMP)
INVENTORY OF PROJECTS/FACILITIES (CONTD)

FIELD OFFICE AND PROJECT	F.O. PRIORITY	FACILITIES	TOTAL ESTIMATED COST ($ IN THOUSANDS)
Nevada			
Nuclear Rocket Development Station Decom.	1	Nuclear Rocket Development Sta.	$ 860
Oak Ridge			
CEER Mayaguez Fac. Decom. Project	1	CEER Mayaguez Facility	2,060
Niagara Falls Storage Site Remed. Action	2	Niagara Falls Storage Site	TBD*
Weldon Spring Site Remedial Action	3	Raffinate Pits 1, 2, 3, & 4 Quarry	TBD*
Molten Salt Reactor Experiment Fac. Decm.	4	Molten Salt Reactor Experiment	TBD*
Low Intensity Test Reactor Decom.	5	Low Intensity Test Reactor	TBD*
ORR Experimental Facilities Decom.	6	ORR GCR A9-B9 Exper. Facility ORR Molten Salt Loop ORR Maritime Ship React. Loop Pneu Tube Irradiation Facility ORR Water-Air Heat Exchanger ORR GCR Loop I ORR GCR Loop II	
Radioisotope Process Facility Decom.	7	3026-D Storage Garden 3033 Storage Garden 3033 Carbon 14 Process System 3506 Waste Evaporator Facility 3515 Fission Prod. Pilot Plant Shielded Transfer Tanks	TBD*
Homogeneous Reactor Experiment No. 2 Decom.	8	Homogeneous Reactor Exper. No. 2	TBD*
Richland			
Shippingport Station Decommissioning Project	1	Shippingport Atomic Power Station	74,750

*Project cost estimate to be determined.

SURPLUS FACILITIES MANAGEMENT PROGRAM (SFMP)
INVENTORY OF PROJECTS/FACILITIES (CONTD)

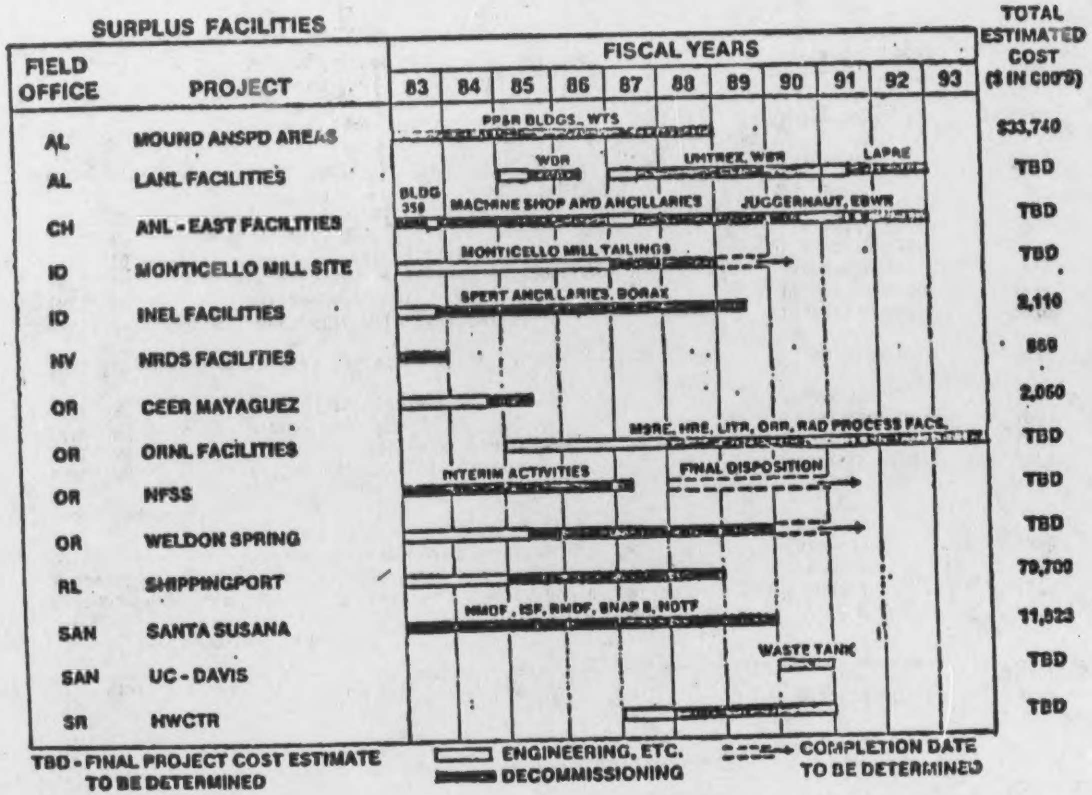
FIELD OFFICE AND PROJECT	F.O. PRIORITY	FACILITIES	TOTAL ESTIMATED COST ($ IN THOUSANDS)
San Francisco			
Nuclear Mat. Dev. Fac. (Bldg. 055) Decom.	1	Nuclear Mat. Dev. Fac. (Bldg. 055)	$ 4,080
SNAP 8 Test Facility (Bldg. 059) Decom.	2	SNAP 8 Test Fac. (Bldg. 059)	3,950
Nuclear Dev. Test Fac. (Bldg. 024) Decom.	3	Nuclear Dev. Test Fac. (Bldg. 024)	2,785
RMDF/ISF Decom.	4	Radioactive Material Disp. Facility RMDF Leach Field Interim Storage Facility	1,008
UC Davis Waste Retention System Decom.	5	R/A Waste Retention System Drywells and Leach Line	TBD*
Savannah River			
Heavy Water Comp. Test Reactor Decom.	1	Heavy Water Comp. Test Reactor	TBD*

*Project cost estimate to be determined.

DECOMMISSIONED SFMP FACILITIES

FIELD OFFICE	SITE	PROJECT/FACILITY	DISPOSITION MODE	YEAR COMPLETED
(Continuing Surveillance Program Required)				
OR	Rincon, PR	Boiling Nuclear Superheater Power Station	Entombment	1970
CH	Piqua, OH	Piqua Nuclear Power Facility	Entombment	1969
--	Hallam, NB	Hallam Nuclear Power Facility	Entombment	1968
(No Surveillance Required)				
AL	LANL, NM	Filter Building, TA-21-153	Dismantlement	1979
	LANL, NM	Los Alamos Molten Plutonium Reactor Experiment	Dismantlement	1980
	LANL, NM	Airwashers	Dismantlement	1980
	LANL, NM	Sodium Storage Tanks	Entombment	1980
CH	Cheswick, PA	Pu Fuel Fabrication Facility	Dismantle/Decon	1982
ID	Monticello, UT	Monticello Mill Site (Mill)	Dismantlement	1979
	INEL, ID	Hallam Components	Decontamination	1979
	INEL, ID	Organic Moderated Reactor Experiment	Dismantlement	1979
	INEL, ID	SPERT IV Test Facility	Dismantle/Decon	1979
	INEL, ID	SPERT II Test Facility	Dismantle/Decon	1980
	INEL, ID	SPERT III Test Facility	Dismantle/Decon	1980
NV	Gnome Site, NM	Gnome Facility	Entombment	1979
OR	ORNL, TN	Radiochemical Waste System	Entombment	1980
SAN	VNC, CA	Advanced Fuels Laboratory	Dismantle/Decon	1982
	SSFL, CA	Sodium Reactor Experiment Facility	Dismantle/Decon	1982

SURPLUS FACILITIES MANAGEMENT PROGRAM
LONG RANGE SCHEDULE



SURPLUS FACILITIES

FIELD OFFICE	PROJECT	TOTAL ESTIMATED COST ($ IN 000'S)
AL	MOUND ANSPD AREAS	$33,740
AL	LANL FACILITIES	TBD
CH	ANL - EAST FACILITIES	TBD
ID	MONTICELLO MILL SITE	TBD
ID	INEL FACILITIES	2,110
NV	NRDS FACILITIES	860
OR	CEER MAYAGUEZ	2,050
OR	ORNL FACILITIES	TBD
OR	NFSS	TBD
OR	WELDON SPRING	TBD
RL	SHIPPINGPORT	79,700
SAN	SANTA SUSANA	11,823
SAN	UC - DAVIS	TBD
SR	HWCTR	TBD

FISCAL YEARS
83
84
85
86
87
88
89
90
91
92
93
PP&R BLDGS., WTS
WDR
UMTREX, WBR
LAPRE
BLDG 350
MACHINE SHOP AND ANCILLARIES
JUGGERNAUT, EBWR
MONTICELLO MILL TAILINGS
SPERT ANCILLARIES, BORAX
MSRE, HRE, LITR, ORR, RAD PROCESS FACS.
INTERIM ACTIVITIES
FINAL DISPOSITION
NMDF, ISF, RMDF, SNAP 8, NDTF
WASTE TANK
ENGINEERING, ETC.
DECOMMISSIONING
COMPLETION DATE TO BE DETERMINED

TBD - FINAL PROJECT COST ESTIMATE TO BE DETERMINED

West Valley Demonstration Project

QUESTION 1: Please explain whether the project is scheduled to be completed on an "as soon as is practical" basis or on some other basis. If some other basis is used (such as the availability of disposal facilities), please justify the choice and explain whether this basis minimizes the costs to the Government.

ANSWER: We are conducting the project, subject to appropriation of funds, on the basis of completing waste solidification and decontamination and decommissioning activities "as soon as practical." We believe that this approach will minimize cost to both the federal and New York State Governments. To further this objective, we will use existing and available technology and will take maximum benefit from associated developments in both the civilian and defense waste areas. A reduction in funding would necessitate a reduced level of effort causing an increase in the project schedule and cost; on the other hand, increased funding would permit us to carry out the tasks sooner.

The project will be completed when the solidified waste is transported off-site to an appropriate federal facility. Thus, completion of the project depends on the availability of a federal facility, which could be a monitored retrievable storage facility, a test and evaluation facility, a geologic repository, or some other facility. After waste solidification and facility decontamination and decommissioning have been achieved, the costs to stand by awaiting an appropriate waste facility to be available will be much less than if the delay occurred before these activities. Thus, the "as soon as practical" approach would be preferred even if disposal facilities were delayed.

QUESTION 2: Please explain whether it is more expensive for the government to decontaminate and use existing facilities or to build new facilities adjacent to existing facilities.

ANSWER: Detailed costs comparisons cannot be made, in that the cost of decontamination for reuse is subject to considerable uncertainty. To the extent that it would cause extensive project delays, reuse of existing facilities is not attractive. The approach we are taking is to make maximum practical use of existing facilities where this will not compromise critical path activities. We currently believe the least expensive approach will be to construct a small hot cell adjacent to existing facilities to house the glass furnace for solidifying the high-level waste and to decontaminate and reuse existing facilities for essentially all supporting equipment and operations. We have rejected construction of a new stand-alone solidification facility because it would cost upwards of $40 million just for a structure which would be used only for one and one-half to three years. It appeared to us not to be cost effective to pursue that approach. On the other hand, to place a first-of-a-kind system in contaminated cells with poor access for remote installation, operation, maintenance, and dismantlement, also does not appear to be technically viable at this time. In about two years, after we have had experience in decontaminating the cells which could house the melter, and in the course of operating a full-size melter in the component test stand, we will determine finally whether or not we can beneficially use the existing facility for all the equipment. While the potential to do so exists, we would have to say today that that is unlikely. Project activities planned for the next few years are necessary regardless of where we locate the solidification equipment.

QUESTION 3: Please explain whether the new waste solidification facilities at West Valley will be of a modular design so that they may be disassembled and used elsewhere at the completion of the West Valley Project and, if not, why not?

ANSWER: It is our plan that the waste solidification equipment, that is, the feed systems, glass furnace for solidifying the waste, waste handling systems, and portions of the off-gas treatment systems, will be of a modular design. In principle, this will permit cleanup, disassembly, packaging, and transportation for reuse at another site.

QUESTION 4: Please identify the amount of funding to be provided by the State of New York in FY 1984 and beyond and specify whether it is in-kind or cash funding.

ANSWER: We are providing for the record the data sheet for this Project showing the State of New York cash contributions on the non-DOE funding line as design and construction cost tasks at the bottom of page 2. At the time the data sheet was prepared, the New York State Energy Research and Development Authority advised us that they had budgeted about $1 million in direct cash funding. In our discussion with the Chairman of the Authority in Albany, New York, about the Project, he indicated the $1 million funding level was under review by the State Government, and he could not say for certain that it would be forthcoming. The balance of the State's 10 percent share of project costs would consist of in-kind services and credit for the value of the West Valley complex. The Authority is allowed a total credit of $12 million for use of the West Valley complex and up to $900 thousand annually (1980 dollars) for in-kind services of Authority staff and consultants. The balance of the State's share of project costs will be in the form of direct payments or funding for support of specific approved project tasks, such as design and construction activities.

Department of Energy
FY 1984 CONGRESSIONAL BUDGET REQUEST

OPERATING EXPENSE FUNDED PROJECT DATA SHEET
Nuclear Energy

Energy Supply Research and Development
Remedial Actions

(Tabular dollars in thousands. Narrative material in whole dollars.)

West Valley Demonstration Project
West Valley, New York

Total Estimated Cost (TEC): 1/
(For operation, development, design, construction, and decontamination and decommissioning.)

1/ A total estimated cost is not available due to incomplete conceptual design (30% complete); a total cost estimate will be available upon completion of conceptual design (end of FY 1983).

West Valley Demonstration Project
West Valley, New York

Total Estimated Cost (TEC): 1/

(Tabular dollars in thousands. Narrative material in whole dollars.)

	Cumulative Prior Yrs.	FY 1982 Actual			FY 1983 Estimate			FY 1984 Estimate		Cumulative Total	TEC 1/
	Obs.	BA	Obs.	BO	BA	Obs.	BO	BA	BO	BA	BA
Operating expense (DOE):											
Waste solidification (development, design, construction, and processing)	$ 0	$ 700	$ 700	$ 700	$ 3,000	$ 3,000	$ 3,000	$15,700	$15,200	$19,400	$19,400
Site operations	0	7,000	7,000	7,000	5,000	5,000	5,000	10,000	9,500	22,000	22,000
Decontamination and decommissioning	0	300	300	300	2,400	2,400	2,400	4,300	4,300	7,000	7,000
Direct project related support costs	500	1,522	1,563	2,073	2,000	2,000	2,300	6,000	6,000	10,022	10,022
Total operating expenses	500	9,522	9,563	10,073	12,400	12,400	12,700	36,000	35,000	58,422	58,422
Other DOE funding:											
Capital equipment	0	200	200	159	1,000	1,000	1,000	0	0	1,200	1,200
General plant projects	0	0	0	0	2,000	2,000	2,000	0	0	2,000	2,000
Total DOE funding:	500	9,722	9,763	10,232	15,400	15,400	15,700	36,000	35,000	61,622	61,622
Non-DOE funding:2/											
Design and construction	0	96	96	96	600	600	600	1,000	1,000	1,696	1,696
Total Project Funding:	$ 500	$ 9,818	$ 9,859	$10,328	$16,000	$16,000	$16,300	$37,000	$36,000	$63,318	$63,318

1/ A total estimated cost is not available due to incomplete conceptual design (30% complete) and does not include pre-project planning costs. The balance of the funding required to complete this project will be requested in future years.

2/ Represents the Design and Construction tasks funded by the New York State Energy Research and Development Authority (NYSERDA). Other NYSERDA contributions include value of Western New York Nuclear Service Center and NYSERDA services. Total NYSERDA contribution will be 10 percent of amount shown on Total Project Funding line.

West Valley Demonstration Project
West Valley, New York

Total Estimated Cost (TEC): 1/

(Tabular dollars in thousands. Narrative material in whole dollars.)

Description, Objective and Justification

Public Law 96-368, West Valley Demonstration Project Act, authorized the Department of Energy to carry out a high-level liquid nuclear waste demonstration project at the Western New York Nuclear Service Center near West Valley, New York, for the purpose of demonstrating the solidification and preparation of high-level radioactive waste for disposal. By virtue of demonstrating the solidification of liquid high-level wastes, the potential hazards associated with continued storage of the liquid waste at the Center will be diminished.

The project will solidify, in a form suitable for transportation and permanent disposal, the high-level radioactive waste at the Center by vitrification or by such other technology which the Deparment determines to be the most effective for solidification. The project scope includes all activities undertaken in carrying out the solidification, including: (1) processing and immobilization of the liquid high-level wastes; (2) preparation of the Center's premises and facilities to accommodate the solidification processing, including such decontamination of existing facilities and equipment as may be necessary or appropriate; (3) develop and provide containers suitable for the permanent disposal of the wastes solidified at the Center; (4) transportation, as soon as feasible after solidification, of the wastes solidified at the Center to an appropriate Federal repository for permanent disposal; (5) decontamination and decommissioning of the tanks, and other facilities at the Center in which the solidified wastes were stored and other facilities, material, and hardware used in carrying out the solidification of the wastes; and (6) disposal of low-level and transuranic wastes generated from project activities.

Since existing facilities and utilities will be used to support this project, site improvements and utility (water, electrical and sewer) upgrading will be minimal. Utilization of existing facilities will be maximized and new construction kept to a minimum consistent with programmatic and environmental, health and safety needs. A limited amount of new facilities and modifications and/or additions to existing facilities are included to accommodate installation and operation of the solidification equipment, and to provide necessary office space and support for these activities.

Operating expense funds will be used to fund research and development, design, construction, site/facility operation, and decontamination and decommissioning of facilities, material, and hardware used in connection with the project.

1/ A total estimated cost is not available due to incomplete conceptual design (30% complete).

West Valley Demonstration Project
West Valley, New York

Total Estimated Cost (TEC): 1/

(Tabular dollars in thousands. Narrative material in whole dollars.)

(a) Schedule of Planned Activities[2/]

Activity	Start	Complete
Design, procurement and fabrication	3rd Qtr. FY 1982	2nd Qtr. FY 1990
Facility construction	4th Qtr. FY 1983	2nd Qtr. FY 1990
Final decontamination and decommissioning	4th Qtr. FY 1988	Open
Facility startup and cold operation	2nd Qtr. FY 1990	2nd Qtr. FY 1991
Solidification of high-level wastes	2nd Qtr. FY 1991	4th Qtr. FY 1993

(b) Management and Contracting

The project will be managed for the Department by an on-site project office, reporting through the Idaho Operations Office, which is responsible for the day-to-day management and decisionmaking. An operating contractor (West Valley Nuclear Services Company, Inc., a subsidiary of Westinghouse Electric Corporation, was selected in August 1981) will be responsible for the technical management of the high-level waste solidification related activities, site and facility operations, and decontamination and decommissioning. The Department's Project Office and Headquarters approval will be required on matters affecting project policies and technical, cost, and schedule baselines. The State of New York through the New York State Energy Research and Development Authority provides consultation and comment on project activities to the Department as required by the West Valley Demonstration Project Act and the cooperative agreement between the Department and the Authority. To the extent feasible, design, procurement, construction and inspection will be by fixed-price contractor and subcontractors awarded on the basis of competitive bids. However, due to the complexity of the work, it may be necessary to utilize cost plus fixed fee contracts for portions of the work. Award fee contracts will be used when justified. Contracting will be by the Department or the operating contractor, depending on the nature and scope of work.

1/ A total estimated cost is not available due to incomplete conceptual design (30% complete).

2/ Estimated start and completion dates are based on latest available information. A baseline project schedule will be available upon completion of the conceptual design (end of FY 1983). Based on preliminary information, solidification is anticipated to take three years beginning in the late 1980's followed by completion of decontamination and decommissioning activities in the mid 1990's.

(c) Prior Year Achievements (FY 1982)

The Department assumed responsibility for site operation on February 25, 1982. Facility restoration and upgrading began in March 1982. Conceptual design of the waste solidification facilities and decontamination of critical facility areas and hot cells for project reuse was initiated in June 1982. The Final Environmental Impact Statement was issued in July 1982 followed by a Record of Decision in August. A borosilicate glass canister using a 90% scale liquid fed ceramic melter with simulated, non-radioactive West Valley waste was produced in August 1982. Samples of the neutralized waste were obtained in August 1982 to assist in design of waste removal and solidification equipment. Initial staffing of Department and operating contractor offices (e.g., facility operations; engineering; project management and control; environmental, health and safety; quality assurance; and decontamination) was completed.

(d) Current Year (FY 1983)

Conceptual design of the solidification process and selection of an architect-engineering firm for performance of preliminary design (Title I) will be completed. Decontamination planning and operations will continue. Development of a program for removing the waste (particularly the sludge which has formed in the bottom of the tank containing the neutralized liquid waste) is planned, and may include construction of models to verify removal techniques and for operator training. Waste solidification development program will focus on verification of applicable technology with emphasis on the following areas: waste characterization, waste form characteristics and behavior, sludge-supernate separation and pretreatment, sodium removal, and residual salt cake handling. Program/project management systems necessary for carrying out the project will be in place; including policies, plans, procedures, and earned-value performance measurement system.

(e) Reasons for Increases and Decreases

FY 1984 is the first year a data sheet has been submitted for this project.

(f) Cost Estimate

The costs shown are based on planned expenditures through FY 1984. A definitive cost and schedule estimate is not available and is being prepared as part of the conceptual design effort. A cost estimate through waste solidification, but not including final decontamination and decommissioning (D&D), is being prepared during FY 1983. The cost estimate includes all costs associated with the West Valley project: R&D, design, construction, waste immobilization, decontamination and decommissioning of existing hot cells for project reuse.

1/ A total estimated cost is not available due to incomplete conceptual design (30% complete).

(Tabular dollars in thousands. Narrative material in whole dollars.)

(f) Cost Estimate (continued)

site/facility operation and maintenance, and project management. The cost estimate will be updated to include final D&D when sufficient information is available to perform the analysis.

	Total Cost[2]
High-Level Waste Solidification	$ 19,400
Site Operations	22,000
Decontamination and Decommissioning	7,000
Direct Project Related Support	10,022
Capital Equipment	1,200
General Plant Projects	2,000
Total DOE Cost	61,622
Non-DOE Costs	1,696
Total Estimated Cost	$ 63,318

High-Level Waste Solidification

This category provides for development, design, construction, and processing activities related to immobilization and preparation of the high-level waste for permanent disposal.

(1) Development - includes confirmatory or prototypic development program, including component test stand and mockups.

(2) Design - includes conceptual, preliminary and final design, inspection services, system(s) acceptance testing, and facility startup.

(3) Buildings and structures - includes modification and construction of facilities for waste solidification and supporting systems/ activities, field offices, and storage sheds.

(4) Special equipment - includes waste removal, transfer and solidification systems, auxiliary systems (e.g., radioactive off-gas treatment system), and canisters necessary to carry out the waste immobilization program.

(5) Processing - includes labor and material costs for immobilizing the high-level waste.

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[1] A total estimated cost is not available due to incomplete conceptual design (30% complete).
[2] Thru FY 1984 only.

(f) Cost Estimate (continued)

Site Operations

Operations include site/facility operations, maintenance, restoration and upgrade necessary to support waste solidification, decontamination and decommissioning, environmental and occupational safety, and security and safeguards requirements.

Decontamination and Decommissioning

This category covers the planning, engineering, equipment and operations necessary for project decontamination and decommissioning (D&D). It also provides for both initial decontamination to prepare contaminated areas and hot cells for reuse by the project and final D&D of storage tanks, facilities, hardware, and materials used in connection with the solidification project.

Direct Project Related Support

This category provides for technical, administrative, and overall management control of the project. Activities performed support other project elements and include items such as environmental impact statements and other environmental documentation, safety analyses, public communication program, cost/schedule control systems, training, project reports, quality assurance program, and records management.

Capital Equipment

This category provides equipment used in initial site takeover operations and restoration activities, such as health physics and environmental monitoring instrumentation and equipment, decontamination and decommissioning tools and equipment, manipulators and hot cell lights, and analytical chemical laboratory equipment.

General Plant Projects

This category provides for miscellaneous small construction and improvement projects, such as installation of a meteorological and environmental monitoring laboratory, construction of a low-level/transuranic waste sorting facility, construction of a facility to protect the component test stand, and upgrade of the low-level waste treatment facility and laundry.

1/ A total estimated cost is not available due to incomplete conceptual design (30% complete).

QUESTION 5: What fraction of the FY 1984 funding for this Project will be used to decontaminate existing facilities at the site?

ANSWER: The data sheet for this project, provided for the record in a previous response, shows cumulative and annual totals for each major activity (page 2). In FY 1984 we estimate about $4.3 million will be devoted to Decontamination and Decommissioning.

1984 DEPARTMENT OF ENERGY AUTHORIZATION

WEDNESDAY, MARCH 2, 1983

House of Representatives,
Committee on Science and Technology,
Subcommittee on Energy Research and Production,
Washington, D.C.

The subcommittee met, pursuant to notice, at 9:30 a.m., in room 2325, Rayburn House Office Building, Hon. Marilyn Lloyd Bouquard (chairman of the subcommittee) presiding.

Present: Representatives Bouquard, Ottinger, Lundine, Valentine, Lujan, Walker, and Chandler.

Staff present: Louis Ventre, counsel; Ron Williams, science consultant; David D. Clement, minority counsel; Joyce Friewald, minority science consultant; and William T. Harvey, minority energy coordinator.

[The opening statement of Mrs. Bouquard follows:]

Opening Statement of Hon. Marilyn Lloyd Bouquard, March 12, 1983, Subcommittee on Energy Research and Production

The subcommittee will come to order. Without objection, our proceedings today may be covered and recorded by the media and other persons. Hearing none, so ordered.

Good morning, ladies and gentleman. Today we will be receiving testimony from witnesses outside of the Department of Energy on the Government's civilian nuclear waste research and development program, and the nuclear fuel cycle research and development program. The subcommittee has already received testimony from the Department of Energy on these programs on February 22 and 24, 1983. Out intent in conducting this hearing is to receive independent testimony on the scope, direction and need for the various activities in the subject programs.

The subcommittee will be particularly interested in receiving the comments of the witnesses on whether the Department of Energy has appropriately assigned the costs of the various activities of the program to either the Federal appropriations or the nuclear waste fund recently created by the Nuclear Waste Policy Act of 1982.

The subcommittee will also wish to explore with the witnesses their views on the need for a colocated test and evaluation facility [TEF] and repository. The subcommittee, during the debate on the Waste Policy Act, had initially decided that the most benefit would probably be derived from a TEF colocated with a repository. The act, however, was significantly modified in House negotiations and in the Senate, and new limitations on the timing and construction of the TEF were ultimately included in the act. We do, therefore, wish to understand the various viewpoints relative to the utility and timing of the TEF in the repository program.

We will also receive testimony today on spent fuel reprocessing and particularly on how reprocessing can dramatically shorten the duration of the time required for radioactive decay of repository wastes. The subcommittee is also interested in the value of strategic materials contained in spent fuel and in research and development in advanced spent fuel separation techniques.

We are fortunate today to have with us a most distinguished group of representatives of the industry and the congressional Office of Technology Assessment. Our first witness on nuclear waste research and development will be Dr. Linn Draper of the Gulf States Utilities Company who will be representing the American Nuclear Energy Council and the Edison Electric Institute. Our next witness on nuclear waste will be Dr. Thomas Cotton from the congressional Office of Technology Assessment. And finally, our third witness on nuclear waste will be Dr. Raul Deju from the Rockwell International Corporation in Richland, Washington.

Our panel witnesses on Nuclear Fuel Cycle R&D will be Mr. John Gray, the Chairman and Chief Executive Officer of International Energy Associates, Ltd., and Mr. Vincent Boyer, Senior Vice President of Nuclear Power of the Philadelphia Electric Company.

Before we begin to accept testimony from the witnesses, I would like to ask if the Ranking Republican Member of our Subcommittee, the Gentleman from Pennsylvania, Mr. Walker would like to make any opening remarks at this point.

Dr. Draper, welcome back to our Subcommittee. Dr. Draper was last before this Subcommittee on June 17, 1981 when we solicited his learned counsel on one of the nuclear waste bills under consideration at that time. We are pleased to see you here again. Dr. Draper, you may summarize your statement or proceed as you wish.

Mrs. **BOUQUARD**. The subcommittee will come to order.

Without objection, our proceedings today may be covered and recorded by the media and other persons. Hearing no objection, so ordered.

Good morning, ladies and gentlemen. Today we will be receiving testimony from witnesses outside of the Department of Energy on the Government's civilian nuclear waste research and development program. The subcommittee has already received testimony from the Department of Energy on these programs on February 22 and 24. Our intent in conducting this hearing is to receive independent testimony on the scope, direction, and need for the various activities in the subject program.

The subcommittee will be particularly interested in receiving the comments of the witnesses on whether the Department of Energy has appropriately assigned the costs of the various activities of the program to either the Federal appropriations or the nuclear waste fund recently created by the Nuclear Waste Policy Act of 1982.

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Our panel witnesses on nuclear fuel cycle R&D will be Mr. John Gray, chairman and chief executive officer of International Energy Associates, and Mr. Vincent Boyer, who is senior vice president of nuclear power in the Philadelphia Electric Co.

I understand that Mr. Walker and Mr. Lujan have opening statements. Mr. Walker is the ranking Republican member of the subcommittee. Without objection, their opening statements will be made a part of the record at this point.

[The opening statements of Mr. Walker and Mr. Lujan follow:]

OPENING REMARKS OF REPRESENTATIVE ROBERT S. WALKER
MARCH 2, 1983

THANK YOU MADAME CHAIRMAN, AND I WOULD LIKE TO JOIN YOU IN WELCOMING OUR WITNESSES HERE TODAY.

OUR TOPIC THIS MORNING IS NUCLEAR WASTE DISPOSAL, AND I MUST SAY THAT LAST NIGHT AS I WENT OVER THE TESTIMONY THAT I WAS STRUCK BY THE FACT THAT WE ARE IN SERIOUS TROUBLE IN THIS COUNTRY IN REGARDS TO WHAT WE ARE GOING TO DO WITH THAT GROWING STOCKPILE OF NUCLEAR WASTE WE ARE ACCUMULATING.

TODAY WE WILL HEAR A NUMBER OF WITNESS WHO WILL NOT ONLY TELL US IN SPECIFIC DETAIL WHAT MUST BE DONE, THEY WILL ALSO MAKE SOME RECOMMENDATIONS AS TO HOW WE SHOULD RESOLVE THE PROBLEMS FACING US.

I COULD NOT HELP BUT THINK THAT THE OVERALL PROBLEM OF NUCLEAR WASTE HAS NOT BEEN ADEQUATELY ADDRESSED IN AMERICA TO DATE. LAST YEAR WE PASSED THE NUCLEAR WASTE POLICY ACT OF 1982. THIS WAS THE FIRST COMPREHENSIVE LOOK AT THE NUCLEAR FUEL CYCLE WHICH ADDRESSED BOTH THE FRONT AND THE BACK ENDS OF THAT CYCLE. BUT, IT APPEARS NOW THAT EVEN THAT ACT DOES NOT NECESSARILY GO FAR ENOUGH.

I AM PARTICULARLY INTERESTED IN THE PROBLEMS OF NUCLEAR WASTE DISPOSAL BECAUSE UP IN PENNSYLVANIA WE ARE SITTING ON THE LARGEST

DE FACTO NUCLEAR WASTE REPOSITORY IN THE WORLD. THE NUMBER OF PROBLEMS WHICH WE FACE IN CLEANING UP THE CRIPPLED TMI - II REACTOR ARE ALMOST BEYOND COMPREHENSION. WE REALIZE THAT DUE TO THAT UNFORTUNATE ACCIDENT WE HAVE BECOME THE TESTING GROUND FOR MANY THEORIES AND PLANS, AND SO FAR, THEY SEEM TO BE WORKING.

BUT, IN PENNSYLVANIA, WE REALIZE THAT THE PROBLEMS OF DISPOSAL AND DECONTAMINATION ARE FAR MORE SERIOUS, AND FAR MORE DIFFICULT THAN THE AVERAGE AMERICAN REALIZES. THE IMPORTANCE OF THE PROGRAMS WE ARE REVIEWING TODAY CANNOT BE OVERSTATED. THEY DESERVE THE ATTENTION OF NOT JUST THIS COMMITTEE, BUT OF THE ENTIRE CONGRESS.

THANK YOU, MADAME CHAIRMAN.

OPENING STATEMENT OF THE
HONORABLE MANUEL LUJAN, JR.

ENERGY RESEARCH AND PRODUCTION SUBCOMMITTEE
HEARING ON NUCLEAR WASTE MANAGEMENT AND THE NUCLEAR FUEL CYCLE

MARCH 2, 1983

THANK YOU, MADAM CHAIRMAN. LAST YEAR, I HAD THE PLEASURE OF WORKING WITH YOU TOWARDS THE PASSAGE OF THE HIGH LEVEL NUCLEAR WASTE POLICY ACT OF 1982. THIS WAS A SIGNIFICANT PIECE OF LEGISLATION WHICH WE CAN ALL BE PROUD OF. I WILL JOIN YOU AGAIN IN WATCHING WITH GREAT INTEREST THE IMPLEMENTATION OF THIS ACT. THE DEVELOPMENT OF A HIGH-LEVEL WASTE REPOSITORY WILL BE A MAJOR STEP TOWARDS SOLVING THE NATIONAL CONCERNS ABOUT NUCLEAR WASTE.

THE WASTE BILL CONCENTRATED ON A DEEP GEOLOGIC REPOSITORY. THIS SHOULD CONTINUE TO BE OUR MAIN PROGRAM. HOWEVER, I BELIEVE THAT WE MUST CONTINUE TO DO SOME ADDITIONAL RESEARCH IN CERTAIN AREAS OF NUCLEAR WASTE DISPOSAL. THE INTERNATIONAL COMMUNITY HAS HAD A STEADY AND GROWING INTEREST IN SUBSEABED DISPOSAL. ALTHOUGH I WOULD NOT ADVOCATE THAT THE SUBSEABED DISPOSAL BE CONSIDERED FOR HIGH LEVEL WASTES, I BELIEVE THAT CERTAIN FORMS OF NUCLEAR WASTES MAY BE APPROPRIATE FOR SUBSEABED DISPOSAL, SUCH AS TRANSURANICS. I HOPE ALL THE MEMBERS OF THIS COMMITTEE ARE AWARE THAT SUBSEABED DISPOSAL IS NOT TO BE CONFUSED WITH OCEAN DUMPING OR SEA DISPOSAL

OF NUCLEAR WASTES. IN SUBSEABED DISPOSAL, CERTAIN AREAS OF THE OCEAN BOTTOM WHICH HAVE NOT BEEN DISTURBED FOR MILLIONS OF YEARS HAVE BUILT UP DEEP LAYERS OF DEPOSITS WHICH ARE UNIQUELY CAPABLE OF PREVENTING THE MIGRATION OF RADIONUCLIDES. THERE ARE SOME TECHNICAL ISSUES TO BE RESOLVED IN THE NEXT YEARS THROUGH RESEARCH BEING CONDUCTED AT SANDIA NATIONAL LABORATORY, WOODS HOLE AT MIT, THE UNIVERSITY OF NEW HAMPSHIRE, AND AT UNIVERSITIES IN OTHER STATES INCLUDING TEXAS AND OREGON. IT SHOULD BE THE POLICY OF THE COMMITTEE TO SUPPORT THIS SMALL SCALE RESEARCH EFFORT FOR THE NEXT TWO YEARS SO THAT THE TECHNICAL ISSUES CAN BE RESOLVED. THE U.S. RESEARCH IS OF GREAT INTEREST TO THE OTHER COUNTRIES INVOLVED IN SUBSEABED DISPOSAL. OF COURSE, WE SHOULD ALSO CONTINUE TO PARTICIPATE IN THE INTERNATIONAL SUBSEABED DISPOSAL PROGRAM. I CANNOT AGREE WITH STATEMENTS THAT THIS COMMITTEE'S POLICY IS TO ONLY SUPPORT THE INTERNATIONAL PORTION OF THE SUBSEABED DISPOSAL PROGRAM BUT NOT THE R&D PORTION.

I WOULD LIKE TO TAKE THIS OPPORTUNITY TO COMMENT ON ANOTHER ASPECT OF THE NUCLEAR FUEL CYCLE. AS YOU KNOW, MADAM CHAIRMAN, I INTRODUCED TWO BILLS EARLY IN THE LAST CONGRESS THAT ADDRESSED THE NUCLEAR FUEL CYCLE. ONE BILL PROPOSES A REVOLVING FUND FOR URANIUM ENRICHMENT. THE OTHER BILL WOULD HAVE ESTABLISHED A CORPORATION INVOLVING BOTH GOVERNMENT AND INDUSTRY TO DEMONSTRATE THE COMMERCIAL VIABILITY OF REPROCESSING. THE SITUATION HAS

CHANGED IN THE PAST TWO YEARS, BUT I STILL BELIEVE THAT WE SHOULD LOOK INTO WAYS TO CLOSE THE NUCLEAR FUEL CYCLE, AND I STILL BELIEVE THAT CONCEPTS SUCH AS REVOLVING FUNDS AND GOVERNMENT CORPORATIONS SHOULD BE USED TO SUPPORT NUCLEAR ENERGY. A KEY STRENGTH IN THE HIGH-LEVEL NUCLEAR WASTE POLICY ACT OF 1982 WAS THAT THE ENTIRE REPOSITORY DEVELOPMENT PROGRAM WILL BE PAID FOR BY A TRUST FUND CREATED THROUGH UTILITY CONTRIBUTIONS.

ONE OF MY BASIC GOALS IS TO SEE THAT THE USER PAYS FOR SERVICES. FOR INSTANCE, WE COULD EXPAND THE CONCEPT OF THE WASTE BILL TO COVER THE ENTIRE NUCLEAR FUEL CYCLE. A TRUST WOULD BE CREATED THROUGH UTILITY CONTRIBUTIONS AND WOULD COVER THE COST OF URANIUM ENRICHMENT SERVICES, REPROCESSING WASTE DISPOSAL, AND THE SUPPORTING R&D ACTIVITIES. THE ACTUAL USERS OF NUCLEAR POWER, WHO RECEIVE THE BENEFITS OF THESE FEDERAL PROGRAMS, WOULD PAY FOR THE OPERATION COSTS AND THE RESEARCH PROGRAMS, RATHER THAN THE GENERAL TAXPAYERS.

MADAM CHAIRMAN, I HOPE WE WILL HAVE ADDITIONAL OPPORTUNITIES TO DISCUSS THESE IDEAS. NOW I LOOK FORWARD TO HEARING FROM OUR WITNESSES. THANK YOU.

Mrs. **Bouquard**. Dr. Draper, we certainly welcome you back to our subcommittee. Dr. Draper was last before this committee on June 17, 1981, when we solicited his learned counsel on one of the nuclear-waste bills that was under consideration at that time. We are very pleased to see you here again, Dr. Draper. You may summarize your statement or proceed as you wish, but your entire statement will be made a part of the record.

STATEMENT OF E. LINN DRAPER, JR., SENIOR VICE PRESIDENT FOR EXTERNAL AFFAIRS, GULF STATES UTILITIES CO., ON BEHALF OF THE EDISON ELECTRIC INSTITUTE, THE UTILITY NUCLEAR WASTE MANAGEMENT GROUP, AND THE AMERICAN NUCLEAR ENERGY COUNCIL

Dr. **Draper**. Thank you very much, Madam Chairman and members of the subcommittee. My name is E. Linn Draper, Jr. I am senior vice president for external affairs of Gulf States Utilities Co.; chairman of the steering committee of the Utility Nuclear Waste Management Group; and a member of the Edison Electric Institute's Nuclear Power Executive Advisory Committee. I am pleased to testify today on the Department of Energy's civilian nuclear waste management program.

I am speaking on behalf of the Edison Electric Institute, the Utility Nuclear Waste Management Group, and the American Nuclear Energy Council. The Edison Electric Institute is the association of the Nation's investor-owned utilities. The member utilities of EEI provide about 78 percent of the Nation's electricity and serve over 67 million customers. The Utility Nuclear Waste Management Group is comprised of 43 utilities with specific interest relating to nuclear waste management. The American Nuclear Energy Council represents more than 100 organizations having an interest in nuclear power, including private, public, and cooperatively owned utilities, manufacturers, architect-engineers, and various firms in the nuclear fuel cycle.

The Nuclear Waste Policy Act of 1982, signed into law by the President on January 7, 1983, has codified the Federal Government's responsibility for disposing of spent nuclear fuel and high level radioactive waste. The nuclear industry, including those utilities which rely on nuclear energy to meet a significant and growing share of their customers' energy requirements, are vitally interested in how the Federal Government carries out this responsibility.

Since 1976, when the Utility Nuclear Waste Management Group was formed, the nuclear industry has been working actively with Congress and the executive branch to formulate a rational nuclear waste policy. EEI, UNWMG, and ANEC believe that the Nuclear Waste Policy Act provides the coherence and direction which the nuclear waste program needs. The institutional, regulatory, political, and financial framework created by the act should give the Nation the assurance that the job will be done and done in a timely fashion. I would like to take this opportunity to thank the committee for its major role in providing this significant legislation.

The Nuclear Waste Policy Act establishes a formidable schedule of activities for DOE. The earliest deadlines fixed by the act are as near as April 7. Others extend almost into the next century. We are confident that DOE can meet these deadlines. We are also confident that Congress, including this important subcommittee, will closely monitor the agency's progress to assure that the program remains on track.

DOE has responded vigorously to the mandates of the act. We are reassured by the testimony last week to this subcommittee of Robert Morgan, Project Director of DOE's Nuclear Waste Policy Act Office. Mr. Morgan restated the Department's determination to meet the requirements of the act. We are particularly pleased with Mr. Morgan's emphasis on the institutional issues and concerns. As he candidly acknowledged, these are "of critical importance to the success and ultimate public acceptance of this program." We agree.

DOE must, as Mr. Morgan promised, continue to give equal consideration to both the institutional processes and the technical requirements. In this regard, the person chosen to head the Office of Civilian Radioactive Waste Management, established by section 304 of the act, should be at least as capable of handling the institutional issues surrounding its civilian nuclear waste management program as he is with the technical ones.

In terms of the technical component of DOE's program, the work appears to be on target. Mr. Morgan's testimony summarized a few of the major accomplishments, particularly relating to the site exploration phase for repositories in basalt, tuff, and salt. Required technical studies are being completed and NEPA documentation prepared. We are seeing evidence that DOE headquarters is taking charge in exerting more effective control over activities in the field.

One of the issues which you have asked us to discuss is DOE's allocation between repository-related research and development and generic R&D. Generic R&D is to be financed by direct congressional appropriations. On the other hand, under section 302(d) of the Nuclear Waste Policy Act, repository-related R&D is funded from the Nuclear Waste Fund. The Fund receives its money from fees paid by the owners and generators of spent fuel and high-level waste. These fees derive ultimately from electric utility customers. Naturally, the nuclear industry has a significant interest in insuring that the disposition of these fees is in the best interest of the ratepayers.

Since the Nuclear Waste Fund is only now being set up, it is premature to reach any definitive conclusions on DOE's funding allocations. The early signs, however, point to the right direction. The program has moved largely into the site-specific stage. Thus, most of DOE's R&D funding should now be nongeneric. The relatively few activities which Mr. Morgan described as ineligible for Nuclear Waste Fund support appear to be properly excluded. However, DOE will be administering the fund for decades to come. We will all need to revisit this topic in the years ahead.

This brings me to my final thought. DOE's proposed contract for the disposal of spent fuel and high-level waste, published in the Federal Register on February 4, will require the owners and generators of spent fuel and high-level waste to pay billions of dollars into the Nuclear Waste Fund over the next several decades, in exchange for DOE's obligation to dispose of those materials.

Normally, when my company contracts to buy a product or service, we insist on the right to audit and inspect. We believe that we should have similar rights with respect to the waste disposal program and the Nuclear Waste Fund. These rights would give the parties most directly affected the ability to determine that the waste program remains on track. Utilities will be able to assure their customers and their regulatory bodies that set our rates that the disposal fees are being properly spent. Some restricted form of audit rights would also allow us to assure that DOE will continue to properly allocate between repository-related and generic R&D. Such access to the waste program, including observation of how the nuclear waste fund moneys are being spent, will also allow us to speak authoritatively when this subcommittee holds hearings like today's during coming years.

We appreciate the opportunity to testify before you today, and we commend the subcommittee for continuing its high level of interest in this important area. Thank you very much.

[The prepared statement of Dr. Draper follows:]

PREPARED STATEMENT OF E. LINN DRAPER, JR., SENIOR VICE PRESIDENT—EXTERNAL AFFAIRS, GULF STATES UTILITIES COMPANY

Madam Chairman and members of the subcommittee: My name is E. Linn Draper, Jr. I am Senior Vice President—External Affairs, Gulf State Utilities Company, Chairman of the Steering Committee of the Utility Nuclear Waste Management Group, and a member of the Edison Electric Institute's Nuclear Power Executive Advisory Committee.

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Since 1976, when the Utility Waste Management Group was formed, the nuclear industry has been working actively with Congress and the Executive Branch to formulate a rational nuclear waste policy. EEI, UNWMG, and ANEC believe that the Nuclear Waste Policy Act provides the coherency and direction which the nuclear waste program needs. The institutional, regulatory, political and financial framework created by the Act should give the nation the assurance that the job will be done, and done in a timely fashion. I would like to take this opportunity to thank the Committee for its major role in providing this significant legislation.

The Nuclear Waste Policy Act establishes a formidable schedule of activities for DOE. The earliest deadlines fixed by the Act are as near as April 7; others extend almost into the next century. We are confident that DOE can meet these deadlines. We are also confident that Congress, including this important Subcommittee, will closely monitor the agency's progress to assure that the program remains on track.

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We appreciate the opportunity to testify before you today and we commend the Subcommittee for continuing its high level of interest in this important area.

Mrs. BOUQUARD. Thank you very much, Dr. Draper.

The Chair takes notice that Mr. Walker is now here. We have included your opening statement in the record.

Mr. WALKER. Thank you, Madam Chairman. I appreciate that.

Mr. LUJAN. Madam Chairman, I had an opening statement which I do not have with me, but it is a statement that I need to make, and I would ask unanimous consent that it be included in the record immediately following your remarks.

Mrs. BOUQUARD. That has already been approved. Does the gentleman from New York have an opening statement?

Mr. OTTINGER. I will ask for the same privilege.

Mrs. **Bouquard**. Without objection, all the members will have the opportunity to include an opening statement in the record.

On page 2 of your testimony Dr Draper, you mentioned that DOE is vigorously responding to the Waste Act. Do you think that they are really devoting adequate or sufficient resources to the mission plan as required by the act to address the technical and the institutional problems?

Mr. **Draper**. We certainly think that the mission plan is a very important component of their activities. It is my impression that in these very early days, they have been faced with deadlines that come quickly, and the preponderance of their activities has been devoted to meeting those deadlines. However, I would expect that as those deadlines are met, they would continue to work on the mission plan, and we are hopeful that such a plan will exist.

We certainly agree that it is very important that a carefully thought-out, well-defined mission plan is ultimately arrived at.

Mrs. **Bouquard**. Something that is of pretty grave concern to me is that industry has a role to play in this venture as well as the Department of Energy, and that is for the utility industry to monitor DOE's activities. Since these costs are going to be passed on to the ratepayers, do you feel that there is sufficient motivation to do the kind of monitoring that I think is going to be essential?

Mr. **Draper**. I think there is. The utilities are mindful of the fact that their product has become increasingly expensive and a matter of concern to their customers. Anything that increases the cost of electric power generation is now of concern to the utility industry. I think that there is adequate evidence that we as an industry are interested in holding costs down, and it is really to that end that the last part of my testimony speaks—that is, the hope that we would have some sort of a mechanism by which we can audit the activities of the Department of Energy on an ongoing basis so that we can assure that in fact the moneys are being well spent.

We would also hope that we would have an opportunity, from time to time, to meet with the Department of Energy in a sitdown discussion sort of mode to discuss the direction that the program is taking and provide our input to their planning.

Mrs. **Bouquard**. I think it is very important that some sort of review procedures be set up to formalize this procedure.

Mr. **Draper**. I am not intimately familiar with what the capabilities are, in terms of Government interactions with formal or informal groups, but it would seem to me, too, that it would be highly desirable to have some sort of an interaction between the Department of Energy and industry.

Mrs. **Bouquard**. Do you feel that the right to adequately audit and inspect can be provided in the contract with DOE? Do you think that further legislation is required? As I said, I think this is going to have to be a two-way street. You are going to have to audit and monitor and have review procedures, as well as DOE's meeting their responsibility.

Mr. **Draper**. My personal preference would be that we work out an arrangement that is acceptable to both parties, that is the Department of Energy and those who are paying the moneys to the Department of Energy, without requiring additional legislation. I think we can endeavor to move in that direction. If, on the other hand, that does not work, then we would be hopeful that legislation would be passed that would institutionalize a relationship.

Mrs. **Bouquard**. Perhaps further hearings on this subject would be in order at a later time.

Another subject of interest to me is minimizing the cost of the program and thus minimizing the charges to the ratepayer. Do you really believe that DOE approaches the development of the spent fuel storage and transportation and disposal canisters in a way that is going to minimize the ultimate cost to the ratepayers, or is this going about it in a piecemeal fashion, Dr. Draper?

Mr. **Draper**. I think it is a little early to see what the impact of the most recent legislation will be. I think that the Department of Energy recognizes the importance of those two activities—namely the packaging and the transportation—but it is very difficult for me to assess whether or not the program will be effective. I think as time goes on, we will be very interested in how that unfolds.

Mrs. **Bouquard**. We would like to continue to hear from you on this subject, and I do hope that we can have hearings on this later.

Mr. Ottinger.

Mr. **Ottinger**. Thank you, Madam Chairman.

I would like to ask a few questions about the need for an AFR, as you see it at this juncture in your contact with utilities around the country. Is there at this time contemplated any need for AFR provisions in the legislation?

Mr. **Draper**. I think it is likely that a few utilities will require some assistance with an AFR. I think that if the projections are accurate on the amount of spent fuel that is being discharged as a function of time, the amount of spent fuel storage space available, there will be some limited need for an AFR. I would expect it to be modest and be able to be taken care of within the provisions of the Nuclear Waste Policy Act of 1982.

Mr. **Ottinger**. Do you have specifics on that which you can provide to us?

Mr. **Draper**. We certainly can.

Mr. **Ottinger**. Have there been any applications to date from any of the utilities for either expanding existing pools or for dry cask support?

Mr. **Draper**. Let me consult, if I may, with people here who know more about that than I do.

I am told that although as you are well aware there are many applications for reracking spent fuel pools to increase the capacity, there have been no applications for expansion of the size of a pool, nor have there been applications for dry storage.

Mr. **Ottinger**. Can you explain why that is? I am concerned the lack of applications for dry cask storage, because it seems to be such a promising method, and we ought to demonstrate that beyond TVA applications. I have never been able to understand why utilities are reluctant to build new pools or expand existing pools. It just does not seem like it ought to be an extraordinarily expensive proposition.

Mr. **Draper**. On the second of your points, that is the expansion of existing pools or the construction of new ones, I think the reluctance on the part of utilities revolves around the NRC licensing procedures. It would be a major undertaking to construct a new facility at an existing plant site.

Mr. Ottinger. You can provide for accelerated consideration.

Mr. Draper. Only recently, and I think that is likely to be considered very carefully by utilities. Only time will tell whether or not they will avail themselves of that opportunity. On dry storage, I think a good many utilities who are interested in the concept are watching what is happening in Europe and at TVA, and it is quite likely again that applications will be forthcoming to use that technology. The extent to which that will relieve the necessity for an away-from-reactor facility only time will tell.

Mr. Ottinger. I would hope that EEI would communicate with utilities who are concerned in this respect. We put in very strong directions to the NRC to assure that AFR would only be required as a last resort. I think if utilities fail to comply to provide expanded storage, dry cask storage, they will be taking themselves on a very difficult task to persuade the NRC at some future date that it must purchase to keep the AFR.

Has my time expired, Madam Chairman?

Mrs. Bouquard. No. The gentleman may continue.

Mr. Ottinger. I am curious about the industry's priorities with respect to a permanent repository program of the department and the mandate to be included in the legislation for monitored retrievable storage, and the degree to which the industry thinks monitored retrievable storage may be an option which they would expect to pursue, whether they consider it more or less advantageous.

Mr. Draper. I believe I can give the sentiment of the majority of the people in the industry on that issue. I think that most people who have looked carefully at the issue of waste management would say that permanent disposal is the preferable strategy—that is, to find a stable geologic formation with suitable characteristics at a site that has appropriate surface characteristics as well, and to dispose of the material in a way so that it really requires no further human surveillance.

If for some reason or another such a site is more difficult to find than we now think it will be, then the option of monitored retrievable storage, of course, would be embraced. I think that everybody is looking forward to the study that will be done by DOE on the advisability of monitored retrievable storage. That study should provide additional information on whether or not that is as attractive a candidate as some people might think it is. But at this point I would say that most people believe that permanent disposal in a geologic formation is the preferable way to go.

Mrs. Bouquard. Thank you very much, Mr. Ottinger.

Mr. Lujan?

Mr. Lujan. Thank you, Madam Chairman.

Mr. Draper, I want to raise a couple of issues. In the last page of your statement, you talked about the difference between repository-related and generic R&D. In my opening statement which I have had included in the record, one of the items that I was concerned with is subseabed disposal. I am a little disturbed that we seem to be going in the direction of cooperating in the international program but that our R&D portion might take a back seat to that. As you know, substantial R&D work in the subseabed disposal area is done in this country. I would not like to see us take that attitude.

Mr. **Draper**. Yes, I do not think anybody in the industry would be opposed to the continuation of work on subseabed disposal. We believe this generic-type research is not directly related to the plan that is now in place for terrestrial geologic disposal system. Therefore, we believe it would be inappropriate to use the waste fund money for that, but we certainly would support continued generic-type research, including subseabed disposal. I personally think that is a promising alternative that should be explored.

Mr. **Lujan**. I wanted to raise that both as a question to you and as advisory to the committee in this area.

The second item that I raised in my opening statement goes beyond the trust fund for a repository. I have always been under the impression that we ought to have a trust fund for the entire nuclear fuel site, from enrichment through reprocessing, through eventual disposal. Where we called for a 1 mil charge under the waste disposal fund, I have heard that a figure like 3 mils would take care of all of the necessary work for the entire fuel cycle. What is the feeling of the various organizations that you represent that may be doing this?

The reason I say that is, one of the things that we are always badgered about is the subsidies to the nuclear industry from Government. If we can move those on to include them in the rate base, then we can continue with the work without Government subsidies.

Mr. **Draper**. I personally do not believe that there are such subsidies to the nuclear industry. I am familiar with the arguments, and I think that there are more persuasive arguments on the other side of the issue. I am not sure what it is you have in mind with the trust fund for the other aspects of the fuel cycle. What, for example, would the additional monies cover?

Mr. **Lujan**. I do not have these figures right up to the minute, but we spend something like $260 million over and above recovery on enrichment. Does somebody have that figure? Or, let me not use any figure. There is a shortfall in the income and the outgo for enrichment services.

Mrs. **Bouquard**. Would the gentleman yield?

I believe that our enrichment program pays for itself.

Mr. **Lujan**. Maybe I am a little behind for this year, but that has not always been the case.

Mrs. **Bouquard**. We have an appropriation that is later recovered through the cost of the enrichment service. That is recovered.

Mr. **Lujan**. There is no cost to the Government for enrichment?

Mrs. **Bouquard**. There are appropriations, but then the cost is recovered when it is paid back. It is recovered.

Mr. **Lujan**. Totally?

Mrs. **Bouquard**. That is correct.

Mr. **Ottinger**. Would the gentleman yield?

Mr. **Lujan**. Yes.

Mr. **Ottinger**. In enrichment, we are doing in the rubric of R&D what is very substantial Government expenditures. It is a paying proposition.

Mr. **Lujan**. Well, I am surprised. It was always my impression—maybe it has been true in recent years——

Mr. **Draper**. It is certainly true in recent years.

Mr. **Lujan**. But not always?

Mr. **Draper**. I do not know about always, but in recent times there has been a net income to the Government from enrichment activities.

Mrs. **Bouquard**. That is correct.

Mr. **Lujan**. Maybe it is my terminology. We spend money on enrichment that the Government does not get back somehow or another.

Mrs. **Bouquard**. If the gentleman would yield further, we have lost a lot of business because of the change in the policy because of the political aspects, and we would like to get back the customers that we have lost in the past few years. But in previous years, we have recovered all of our losses on the enrichment program.

Mr. **Lujan**. You mean commercially.

Well, then, let us go on to reprocessing which we are not doing but we ought to be doing. The building of a reprocessing plant, the operation of a reprocessing plant, those are the kinds of costs that I am talking about which come out of this fuel cycle fund.

Mr. **Draper**. I must say that I have not thought much about this, and I suspect that people later on this morning who are thinking about reprocessing would be able to address that better than I. Let me just say, at this point we are very pleased to have the waste management fund. We think we have gone a long way, and we would hope that whatever we do from now on would be done separately and apart from that so that we do not confuse that particular issue. The mechanism by which we provide funding for reprocessing, if it is to go on, I think is something that, as you point out, really does require consideration. It is appropriate to begin to think about how that will be done because it is reasonably clear to me that, because of past changes in governmental policy, the people who would take normal business risks are not willing to take the business risk of being in the reprocessing business. They notice that changes in policy can wipe out a very large investment.

So some mechanism, other than the ones that are now in place, I believe would be required for reprocessing to go forward.

Mr. **Lujan**. I thought in terms of an overall fuel cycle fund; very honestly, I do not think we could get a reprocessing fund by itself passed. There might be too much opposition for a fund just for that purpose, just on the reprocessing issue alone. That is why my thinking is going to the entire cycle.

Mr. **Draper**. I am sorry I am not able to comment more intelligently on the issue.

Mrs. **Bouquard**. Mr. Walker?

Mr. **Walker**. Thank you, Madam Chairman.

Mr. Draper, one place where we are finding out a lot about nuclear waste right now is up at Three Mile Island, as we take care of some of the problems up there and deal with some of the waste issues that have arisen out of that. The nuclear industry has decided earlier this year that they are going to put contributions into that as part of the learning process, as part of helping that cleanup proceed on schedule.

Has your utility company agreed to participate in that particular plan for financing Three Mile Island?

Mr. **Draper**. We have not agreed;

Mr. **Walker**. Do you anticipate agreeing?

Mr. **Draper**. I doubt that my company will.

Mr. **Walker**. You do not feel that there is enough to be learned there, that this is something that should be a part of the industry's commitment to this whole business of doing something about nuclear waste?

Mr. **Draper**. I personally think that the knowledge gained will be very valuable. The concern that my company has with that in particular is that it is a large expenditure. We have gotten strong signals from the public utility commissions in the two States in which we operate that such expenditures would not be allowed to be recovered from our customers. We believe that they are sufficiently large expenditures that we simply cannot afford to make them in our current financial condition.

If we were a healthy utility from a financial point of view, we might feel differently about it. Or if legislation were passed that would allow us to pass such costs along as a normal part of doing business, we would doubtless be supporting it. Absent such Federal legislation that would preempt the jurisdiction of our public utility commissions, I believe that our participation will not be forthcoming.

Mr. **Walker**. So your company even opposed the resolution that the nuclear industry adopted, suggesting a voluntary program?

Mr. **Draper**. We did not oppose it. We simply did not contribute to the fund.

Mr. **Walker**. The industry has now specifically called off the idea of coming up here and getting legislation favoring their voluntary program. So what you are saying is, you favor the legislative route and do not favor the voluntary program?

Mr. **Draper**. That is correct.

Mr. **Walker**. The problem, of course, is that if all the utilities across the country take the attitude of your utility, there will be no fund, and therefore the cleanup will not proceed on schedule, and, as a result, nuclear power will continue to have that cloud hanging over its head, and my constituents will continue to have the health and safety problems connected with a hot, damaged reactor operating on Three Mile Island.

Mr. **Draper**. Those utilities that have operating nuclear power plants, and are in sound financial condition, I believe, will be contributors to the Fund. Those utilities such as mine, that do not have operating nuclear power plants and are not in sound financial condition because of massive construction programs, will—at least some—not participate in the fund. The difficulties to which you allude will persist.

Mr. **Walker**. I must admit, and I said before this subcommittee on several occasions, I find it rather discouraging to find that the industry has failed to respond to what is a massive problem for it. If your concern is about construction costs for the future, I can assure you that your construction costs are going to go through the ceiling if Three Mile Island results in the bankruptcy of the company that is involved there. Insofar as there is an industry failure to look at the whole problem, I think that this potential still exists. At that point, the cost of financing construction in the utility industry is going to go through the ceiling, and all consumers are going to pay tremendous costs for the industry having taken a walk on what is not only a problem for that company, but is a problem for the industry as a whole.

Mr. DRAPER. Of course the comments I am making now represent my own company and not the industry; we both recognize that. I share your concern, and I believe the appropriate way to deal with that concern is for Congress to pass legislation that would stipulate that such contributions were in the best interest of all citizens of the United States and that such costs could be passed through, demanding that our public utility commissions would allow us to pass those costs through. Absent such legislation, companies such as mine will be faced with very large expenditures that they will not be able to recover. I think that it is an unreasonable expectation on anyone's part that a company that is not active in the nuclear business in the sense of an operating reactor at this point and does have a massive construction program will voluntarily contribute very large sums of money.

Mr. WALKER. I agree with you. I think Congress has failed miserably in the whole thing, too, and Congress has basically taken a walk on the problem as well, with the exception of this committee and this subcommittee that has made certain that appropriate amounts of research dollars go into the process up there. Other committees in this Congress have jurisdiction and have taken a real walk on the problem. So from that standpoint, I agree with you.

But that still, it seems to me, raises the question, if Congress is unwilling to act, whether the industry that has so much at stake there should also be unwilling to act because of Congress' negligence.

Let me ask you this, in your building program, are you building nuclear reactors?

Mr. DRAPER. Yes. We have one nuclear unit under construction.

Mr. WALKER. I would simply say that if that is the case, the kinds of problems that occurred at Three Mile Island might very well occur to your company, too, because that was a brand new reactor where the problems occurred. That being the case, if you find yourself in the same kind of financial bind as is GPU, with the kind of financial problems you are now facing and the kind of problems that GPU is now faced with, I would suggest that at that point you might also be looking for the industry to be a little more responsive than it has been.

We would hope that no other utility at any time ever has to face what has been faced at Three Mile Island. On the other hand, I think that without an industry response of some sort, we may be assured of having another situation of that type arise.

Mr. DRAPER. If I might respond to that last point, I think it is a very important consideration. You are probably as aware as I am that the industry has done a number of things to assure that such a situation will not prevail in the future—namely, they have not only modified the way nuclear plants are operated, but they have also provided a number of insurance consortia that will provide for cleanup funds in the future.

The industry, of course, is not a monolithic entity. Each company has its own difficulties. And I think that while it is clearly in the best interest of some companies to participate in the cleanup of the existing problem, it may not be in the best interest of every company. My company has evaluated the situation and come to the conclusion that it is not in our best interest, absent Federal legislation, to participate.

Mr. **Walker**. Thank you, Madam Chairman.

Mrs. **Bouquard**. Mr. Lundine?

Mr. **Lundine**. Dr. Draper, I find your testimony very intelligent and your answers to many of the questions likewise. I am, however, concerned with your comments regarding the Nuclear Waste Fund on page 4 and 5 of your testimony; I would like to understand them a little bit better.

While I recognize the distinction you properly make between the generic research on the one hand and the repository related R&D and the other activities authorized by the Nuclear Waste Policy Act, are you saying that by demanding audit or review rights that the industry is backing away from its commitment to providing the monies to the Nuclear Waste Fund to carry out the purpose of the act?

Mr. **Draper**. Absolutely not. The intent of those comments is that we, as the ones that pay the money, would, from time to time, have the opportunity to both meet with the Department of Energy officials and have dialogue on where the program is going and also from time to time to see what it is that the money has been spent for. We have absolutely no interest in backing away from providing funds. We want the program to be adequately funded, but we believe we have a responsibility to our ratepayers from whom we ultimately collect the money to be sure that the funds we give to the Department of Energy are spent for the intended purposes and that the program is one that is effective in doing the job that needs to be done—namely, dispose of waste.

Mr. **Lundine**. Do you think that additional legislation is necessary to accomplish that, or can it be done under the Nuclear Waste Policy Act?

Mr. **Draper**. We discussed this a little bit earlier.

Mr. **Lundine**. I apologize. I did come in a little late, and I do not want to be redundant.

Mr. **Draper**. I will say what I said before. My personal preference is that it be done under the existing framework of law. I believe that it can be done. It would only be if we were not able to establish an effective dialogue with the Department of Energy that additional legislation would be passed. It seems to me, though, that we are off to a very good start. I think there is no difficulty at this point.

Mr. **Lundine**. Your testimony reflects that, and it seems to me that they are, too. I just was concerned, as I think you can understand, with the implication of what you were saying there. I do not think there is anybody who put our heart and soul into the passage of that act that would discourage DOE from meeting with you and being accountable in that sense. But when you start using words like "audit" and "review rights", it raises legal questions in my mind that I wondered what you meant.

Mr. **Draper**. That certainly is not the intent, and I hope I have allayed that concern.

Mr. **Lundine**. Yes, you have. But let me get at it from a little different standpoint. The act requires the development of a mission plan by DOE within 15 months after enactment. I personally believe that the mission plan is very important to provide the utilities with the kind of understanding of how the program is proceeding and to assure that the fees you are paying are spent in the wisest possible way.

Could you comment on whether the industry and yourself personally see the mission plan as important in that regard?

Mr. **Draper**. Absolutely. We think that is an extremely important document, and we are anxiously awaiting its development. We think that it is a key document.

Mr. **Lundine**. Thank you very much.

Mrs. **Bouquard**. Thank you very much. Mr. Chandler?

Mr. **Chandler**. No questions.

Mrs. **Bouquard**. Thank you very much, Dr. Draper. We appreciate your excellent testimony and your willingness to appear before this committee.

Our next witness is Dr. Thomas Cotton, who is also a veteran witness before this subcommittee. We welcome you once again, Dr. Cotton. He is a senior analyst in the congressional Office of Technology Assessment, and he last appeared before this committee in October 1981 to testify on the OTA's nuclear waste study and various legislative proposals that were before the committee.

Dr. Cotton, you may summarize your statement or proceed as you wish. Your written statement will be made a part of the record.

STATEMENT OF THOMAS A. COTTON, SENIOR ANALYST, OFFICE OF TECHNOLOGY ASSESSMENT, WASHINGTON, D.C.

Dr. **Cotton**. Thank you. I would like to orally summarize the statement and submit the full statement for the record.

My name is Thomas Cotton, and I am Director of the Office of Technology Assessment's study of commercial high-level radioactive waste management.

I appreciate the opportunity to appear before the subcommittee today on behalf of OTA to discuss the Department of Energy's radioactive waste management budget.

My testimony focuses on two main points. The first is the need to devote adequate resources to developing a mission plan, and the second is the need for an R&D program to address the technical challenges of operating a waste management system at full scale.

As you know, OTA's study concluded that a mission plan would serve a number of very important functions. First, it could help build confidence that the goals of the act would be met. Second, it would provide a sound basis for calculating the long-term resource requirements for the waste management program, and thus it could be used to justify revisions to the waste management fee and expenditures from the fund. In fact, it would provide a basis for making the determination which R&D funds should be treated as generic and which are required for implementing the Act. Finally, it could serve as a basic management tool for the Department of Energy for coordinating the many activities that have been mandated by this act.

We believe that a credible mission plan will require substantial modifications of DOE's existing plans, since the ground rules for the radioactive waste program have been substantially changed by the passage of the Nuclear Waste Policy Act. DOE plans and programs developed prior to the passage of the act have been based on schedules that are not legally binding and on the assumption that the availability of appropriated funds would be a major constraint on the scope of the program. The Nuclear Waste Policy Act drastically changes that situation, since it makes a major Federal commitment in law to a firm target date for a repository and provides for the necessary resources through the user fee on nuclear utilities.

We conclude that a mission plan for meeting a firm repository schedule must be based on a detailed analysis of the potential technical and institutional failures that could prevent achievement of the goal. It must include measures to minimize the likelihood of failures and contingency plans for mitigating effects of any failures that do occur.

Earlier DOE plans do not seem to reflect this approach, since they generally assume that everything will go right the first time. In contrast, I would note that the National Aeronautics and Space Administration has achieved great success in complex missions by using failure analysis, which is a systematic effort to identify things that might go wrong. I would observe that we are surrounded in this room by evidence of the successes that can be achieved by using failure analysis.

Development on a firm schedule of perhaps the first geologic repository in the world faces not only technical complexities and uncertainties of the sort encountered in NASA missions, but significant institutional uncertainties as well, and the consequences of major programmatic failures could be serious. For this reason, we think that the same planning and management techniques that have been used so successfully in the space program could be valuable in helping to achieve the goals of this act. In fact, we used failure analysis in OTA's waste management study to identify policy options, and it was that analysis that led us to suggest consideration of a pay-as-you-go waste disposal fee as a very important way of minimizing the chances that a lack of funds would hinder the progress of the repository development program.

There is little evidence in the DOE budget submission that DOE plans to put the necessary resources in the development of a mission plan adequate to the new requirements imposed by the act. Mission planning is mentioned only in passing as one of many functions to be performed under supporting R&D, for which about $8.7 million is requested in fiscal year 1984. By contrast, we understand that NASA planning for one typical planetary mission cost around $5 million. The minimal attention to mission planning in the budget submission suggests that it is unlikely that so large a portion of the total allocated for supporting R&D would be available for that purpose. In addition, the fact that DOE mentions mission planning as part of "special studies and support" that would be provided under supporting R&D suggests that the mission plan would be prepared largely by outside contractors, rather than by in-house staff. However, unless there is substantial direct involvement by DOE program staff in the development of the plan, it may have little chance of achieving its potential as a key management tool. Nonetheless, the budget submission does not indicate that a large in-house staff effort would be devoted to mission planning.

For example, mission planning is not mentioned among the justifications for a substantial increase in staffing for fiscal year 1984. In any case, the mission planning effort cannot wait until fiscal year 1984 for adequate staff resources. Much of the initial work on the plan must be done this fiscal year with whatever resources can be made available.

We do recognize that the low emphasis on mission planning in the budget submission may simply reflect the fact that the budget was put together prior to the passage of the Nuclear Waste Policy Act, but if that is the case it makes it very important to address the issue now. Since the Committee on Science and Technology has jurisdiction over NASA, it might be possible to draw upon the considerable mission planning expertise of that agency to assist in reaching judgments about the levels of funding and staffing that would be needed for a mission planning effort of the scale required to meet the goals of this act.

The second point I would like to discuss briefly today is the lack of recognition in the DOE budget proposal of the need for an R&D program to develop the operational capabilities required for a full-scale waste-management system. This would involve developing the technologies and techniques for reliable receiving, packaging, and emplacement of highly radioactive material in repositories, or storage facilities if that is necessary. Once a respository is operational, these tasks will have to be done at an unprecedentedly high annual rate, and thus it is critical that there be provisions for developing the necessary expertise early, before full-scale facilities are designed and built.

To get some perspective on this operational problem, I would just observe that simply to reprocess, store, or dispose of spent fuel fast enough to stop the further buildup of inventories and storage, without even beginning to work off the backlogs that would be in storage already, would require handling about 14,000 spent fuel assemblies in 1998 alone. If this spent fuel were being canned for storage or disposal, it would require filling, sealing, and testing about 8,000 canisters each year. That is about one per hour, if you are working 24 hours per day, 365 days per year.

There is no experience with these procedures at rates remotely approaching those that must be achieved for full-scale operation. For example, the Department of Energy's experience with dry canning of spent fuel at the Nevada Test Site is limited to a total of 17 spent fuel assemblies. Furthermore, there is no experience at all with the procedures that might be required for final packaging of either spent fuel or high-level waste for permanent disposal.

The research and development section of the Nuclear Waste Policy Act explicitly recognizes the importance of operational questions, both in the requirement for tests to be conducted in the T&E facility and in the requirement for generic tests on packaging, handling, and emplacement technology. However, the DOE budget submission does not reflect any emphasis on this subject.

This is consistent with past DOE plans, which have generally paid little attention to operational questions. For example, reference repository loading schedules have assumed that once a construction authorization was granted for a respository, the full scale receiving and packaging facilities would be constructed before operational tests were begun. The risk of this approach is that it would be difficult, if not impossible, to correct any basic weaknesses in the facility design that became apparent during operation, since that would not begin until after construction had already been completed.

If the packaging facilities in fact proved unable to process material at the target rates, it could cause difficulty both for the Department of Energy, which will have already committed to repository delivery schedules, and for the utilities that plan their interim storage provisions on the assumption that such commitments will be met.

The provisions of the Nuclear Waste Policy Act suggest an alternate approach that could increase the likelihood that full-scale facilities will operate at planned rates. This approach could involve three phases prior to full-scale repository operation, allowing development of hands-on experience with large amounts of spent fuel for high-level waste in a series of increasing steps extending over the next 15 years.

The first phase would involve generic packaging, handling, and emplacement tests required by section 217(d) and perhaps the test and evaluation [T&E] activities, if it is decided not to co-locate a T&E facility with a repository. Since many of the operational questions apply to large-scale storage as well as to disposal, such a program could be integrated with the 300 metric ton dry storage research and development program that is authorized in section 218(c).

The second phase of preoperational tests would be a pilot stage of repository operation, which would involve early emplacement in the repository of material packaged during the first phase of tests. This would occur after NRC had granted the construction authorization, but before completion of the repository's own packaging facility. This approach would allow early in-situ verification, in a licensed mode, of the results of the generic emplacement tests, and it would also allow an early test of NRC's process for deciding to allow emplacement of waste in a repository with no intention of retrieval. In this way, it would be analogous to a low-power license for a reactor.

This could be integrated with T&E activities if it were decided to co-locate the T&E facility with a repository.

The final phase of preoperational testing could be a pilot stage of tests for the respository's own packaging facilities. For this stage, only one or two modules of the full-scale packaging facility would be constructed and operated for a period of several years to discover and correct any design problems before constructing the rest of the modules in that facility. Once final designs have been modified as needed in the light of this operational experience, and the full-scale facilities have been completed, the research, development, and demonstration phase would be finished and the operational phase could begin.

Let me emphasize that this is just one option for developing operational capabilities. We believe that one of the very important functions of the mission planning effort would be to identify and evaluate the range of such options that might be available and to select the one that can contribute most effectively to the achievement of the goals of the act.

Madam Chairman, that concludes my remarks today. I would be glad to respond to any remarks you may have.

[The prepared statement of Dr. Cotton follows:]

PREPARED STATEMENT OF THOMAS A. COTTON, OFFICE OF TECHNOLOGY ASSESSMENT

Madam Chairman:

My name is Thomas A. Cotton, and I am the director of the Office of Technology Assessment's study of commercial high level radioactive waste management. Thank you for the opportunity to appear before this Subcommittee today on behalf of OTA to discuss the Department of Energy's radioactive waste management budget.

I testified before this Subcommittee on October 5, 1981, on the subject of the elements of a comprehensive nuclear waste law. At that time I stated that the most critical element of a comprehensive nuclear waste policy appeared to be a commitment in law to a firm and credible schedule for development of a mined geologic repository. Such a commitment is now the cornerstone of the Nuclear Waste Policy Act of 1982. I also testified that OTA's analysis suggested that one of the basic requirements for making a commitment to a firm schedule highly credible is the rapid development of a sound implementation plan - showing precisely how the Federal Government proposes to achieve the legislated schedule. In fact, it was this committee that was responsible for inclusion of a requirement for a radioactive waste mission plan in the final legislation. My testimony today focuses on the need to devote adequate resources to developing such a plan, and to include in that plan an R & D program adequate to meet the technical challenges of operating a waste management system at full scale.

A credible mission plan will require substantial modifications of DOE's existing plans, since the ground rules for the radioactive waste program have been changed by virtue of the passage of the Act. DOE waste management plans and programs developed prior to passage of the Act have been based on internally generated reference schedules that were not legally binding, and on the assumption that availability of appropriated funds would be a major constraint on the scope of the program. The passage of the Nuclear Waste Policy Act drastically changes the situation, since it specifies a major Federal commitment in law to a firm target date for a repository, and provides for the necessary resources through a user fee on nuclear utilities.

We concluded in the OTA study that a mission plan for meeting a firm repository schedule must be based on a detailed analysis of potential technical and institutional failures that could prevent achievement of the goal. It should include measures to minimize the likelihood of such failures, and contingency plans for mitigating the effects of any failures that do occur.

Earlier DOE plans have appeared to be unduly optimistic, assuming that everything will go right the first time, and that every milestone identified in their schedules will be passed successfully. In contrast, the National Aeronautics and Space Administration (NASA) has very successfully used failure analysis -- that is, a systematic effort to identify things that might go wrong -- in planning for complex missions in which there is a very high premium on avoiding failures, either because of the risks to human life or because of the importance of meeting a fixed schedule. Development on schedule of perhaps the first geologic repository for high-level radioactive waste in the world faces not only technical complexities and uncertainties of the sort encountered in NASA missions, but significant institutional uncertainties as well; and the consequences of major programmatic failures could be serious.

The experience of OTA's waste management study brought home to us the value of failure analysis in identifying potential problems that could be avoided through foresight and timely action. Specifically, it was the use of failure analysis that led us to identify the crucial importance of stable and adequate long-term funding of the waste management program as a necessary condition for a credible commitment to a firm schedule. It was that finding that in turn led us to suggest consideration of a "pay as you go" user fee on nuclear utilities as a way of guaranteeing the availability of adequate resources when they were needed. We believe that the inclusion of a user fee in the Nuclear Waste Policy Act of 1982 was one of the most important steps that could have been taken to ensure the successful resolution of the nuclear waste problem.

These new program funding provisions should ensure that sufficient funds are available for all program activities needed to meet the goals of the Act, including mission planning. In fact, we concluded in our study that a mission plan is needed to provide a firm basis for estimating the resources that will be required to implement the Act. Thus, it could serve to justify revisions of the waste management fee and appropriations from the Nuclear Waste Fund. A mission plan is also needed as a management tool for coordinating and integrating the many complex activities mandated by the Act into a coherent and cost-effective program for achieving the legislated goals.

There is little evidence in the budget submission that DOE plans to put the necessary resources into development of a mission plan that is adequate to the new requirements imposed by the Act. For example, the funding available for mission planning in either this year's or next year's budget may not be adequate. Mission planning is mentioned only as one of many functions to be performed under Supporting R&D (DOE Budget Request Vol. 2, p. 229). The total appropriation for this category for fiscal year 1983 is $5.4 million, and the request for fiscal year 1984 is about $8.7 million. By contrast, we understand that NASA planning for a typical planetary mission - the Viking mission to Mars - cost around $5 million. The minimal attention to mission planning in the budget submission suggests that it is unlikely that so large a portion of the total allocated to Supporting R & D would be available for that purpose.

In addition, the funds for mission planning do not appear to be included in the most appropriate category of the budget. The fact that DOE mentions mission planning as part of the "special studies and support" to be provided under Supporting R&D suggests that the mission plan would simply be one of a number of studies prepared largely by outside contractors, rather than by in-house staff, who are covered under the separate category of Program Management. In my view, unless there is substantial direct involvement by responsible DOE program staff in the development of the plan, it may have little chance of achieving its potential as a key management tool for coordinating the many activities required to achieve the goals of the Act. Instead, it may only meet the formal reporting requirement of the Act, and not be organically related to the program. In addition, most of the valuable learning that would occur during the planning process would accrue to the contractor, rather than the DOE staff who would subsequently be responsible for implementing the plan.

The budget submission does not indicate that a large in-house staff effort will be devoted to mission planning. The justification under Program Management for a substantial increase in staffing for fiscal year 1984 (pp. 229-230) does not mention mission planning as one of the functional activities requiring a staff increase. This strengthens the impression that DOE intends for most of the work on the preparation of the mission plan to be performed by contract personnel, rather than by DOE staff. Furthermore, the mission planning effort cannot wait until Fiscal Year 1984 for adequate staff resources. The effort must begin now if the deadlines imposed by the Act are to be met. The first draft is due no later than 15 months after the date of passage of the Act, and may be needed earlier to allow adequate time for review, comment, and revision before final submission in 17 months. Thus, much of the initial work on the plan must be done this fiscal year, with whatever resources can be made available. This would suggest that a request for reprogramming fiscal year 1983 funds might be expected. While the Secretary of Energy has detailed a large number of policy planning and analysis personnel to the waste management program to facilitate implementation of the Act, this is apparently only for a limited period of six months, and it is not clear whether any of these personnel have expertise in mission planning.

We recognize that the low emphasis on mission planning in the budget submission may simply reflect the fact that the budget was put together prior to the passage of the Nuclear Waste Policy Act. If so, it makes it all the more important to address the issue now. Given this Committee's jurisdiction over NASA, it might be possible to draw upon the considerable mission planning experience of that agency to assist you in reaching judgments about the levels of funding and staffing needed for a mission planning effort of the scale required to meet the goals of the Act. In any case, we believe it would be important for the committee to address the funding and staffing issue if you agree that the mission planning effort should play a major role in developing DOE's long-term approach for achieving the goals of the Nuclear Waste Policy Act.

From our perspective, a second shortcoming reflected in the DOE budget proposal is the lack of an R & D program to develop the operational capabilities required for a full scale waste management system. Such an R&D program would involve developing the technologies and techniques needed to assure reliable receiving, packaging, and emplacement of spent fuel or high level waste in repositories or storage facilities. Once a repository is operational, these tasks will have to be done at unprecedentedly high annual rates, and thus it is critical that there be provisions for developing the necessary expertise early in the planning cycle, before full-scale facilities are built and operated.

The Department of Energy now estimates that by the time a repository begins operation in January of 1998, some 53,000 metric tons of spent fuel, representing some 190,000 individual spent fuel assemblies, will have been discharged by commercial nuclear reactors. Simply to reprocess, store, or dispose of this spent fuel fast enough to stop the further buildup of inventories in storage in 1998, without even beginning to work off the backlogs, would require handling about 3,900 metric tons, or nearly 14,000 assemblies, in 1998 alone. If this spent fuel were being canned for storage or disposal, it would require filling, sealing, and testing - using remote handling procedures - about 8,000 canisters per year. There is experience with all of the procedures for handling spent fuel through the step of canning for storage, but there is no experience at rates remotely approaching those that must be achieved for full-scale operation. For example, the Department of Energy's experience with dry canning of spent fuel using the Engine Maintenance and Disassembly (E-MAD) facility at the Nevada Test Site is limited to a total of 17 spent fuel assemblies, with a maximum packaging rate of one assembly in one canister in about 12 hours. Furthermore, there is no experience at all with the procedures that might be required for final packaging of either spent fuel or high level waste for permanent disposal, procedures which may be considerably more complex than those required for canning for temporary storage.

The research and development section of the Nuclear Waste Policy Act, for which this Committee is responsible, explicitly recognizes the importance of operational questions both in the requirements for tests to be conducted in a T&E facility, and in the requirement in section 217(d) for use of existing Federal facilities for generic tests on packaging, handling, and emplacement technology. However, the DOE budget submission does not clearly reflect any emphasis on this subject.

Past DOE reference repository development plans have generally paid little, if any, attention to these operational questions, and instead have focused primarily on the problem of finding and licensing the first disposal site. For example, reference repository loading schedules have assumed that once a construction authorization was granted for a repository, the full-scale surface receiving and packaging facilities would be constructed. Operational testing would take place during a 5-8 year shakedown period before increasing to the target full-scale throughput of 6,000 metric tons per year. The risk with this approach is that it would be difficult if not impossible to correct any basic weaknesses in the facility design that became apparent during the shakedown phase, since construction would have been completed. If the packaging facilities in fact proved unable to process material at the target rates, it could cause difficulties both for DOE, which is now proposing to begin committing to repository delivery schedules in 1991, and to the utilities that receive such commitments and that plan their interim storage provisions on the assumption that such commitments will be met.

The provisions of the Nuclear Waste Policy Act suggest an alternate approach that could increase the likelihood that full-scale facilities will operate at the planned rates, and thus minimize the risk that commitments to delivery schedules cannot be met and that additional interim storage measures would be needed. This approach would involve three phases prior to full-scale repository operation, allowing development of hands-on experience with large amounts of spent fuel and/or high level waste in a series of steps extending over the next 15 years.

The first phase would involve the generic packaging, handling, and emplacement tests required by section 217(d). Since many of the operational questions apply to large-scale storage as well as to disposal, it may be very useful to plan for an integrated storage and disposal operational testing program. Thus, such a program could also include the 300 metric ton dry storage research and development program authorized in section 218(c). As indicated in my testimony to this Subcommittee in October, 1981, such a program could develop packaging and handling technology that would allow the packaged material to be emplaced either in surface storage or in a repository. This could help ensure that spent fuel or high level waste could be accepted at operational rates at a repository site on the target date even if there were delays in full-scale loading of the repository. An integrated storage and disposal test facility would also allow development and demonstration of the capacity to remove waste from a repository at a rate comparable to the emplacement rate - a proposed NRC requirement - and to place it into temporary surface storage if that should prove necessary for any reason. This should help build confidence that initial emplacement of waste into a repository is not an irreversible step.

As I have noted, the Engine Maintenance and Disassembly (E-MAD) facility at the Nevada Test Site is already being used by the Department for packaging small amounts of spent fuel for emplacement in both dry surface storage and in a repository-like facility (the Climax test facility). If the activities at the E-MAD facility can be expanded easily, it might be used to develop and demonstrate waste handling capacity. The DOE budget request shows only funding for maintenance of the E-MAD facility for storage of the small amount of spent fuel that has been used in the Climax tests to date, with no expansion of activities for purposes of section 217(d).

To gain needed operational experience may require a substantial quantity of spent fuel or high level waste. If, for example, it was planned to conduct tests at a scale of only 2 percent of both the total capacity and projected annual handling rate of DOE's current reference repository design, it would require over 1,000 metric tons over the next decade. The actual amount that should be used would be determined in the mission plan by an analysis of (a) the need for reliable data and experience concerning operations with highly radioactive material over a sustained period, and (b) the need for packaged waste or spent fuel for use in the second phase of preoperational tests -- a pilot stage of repository operation.

A pilot stage of operation of the repository would involve early emplacement in the repository of the material packaged during the first phase of tests. This would occur after NRC had granted a construction authorization but before completion of the repository's own packaging facilities. Informal discussions with NRC staff indicate that this would be possible within the existing regulations for repository licensing; it would be analogous to low-power licensing for a reactor. This approach would allow early in situ verification of the results of the generic emplacement tests. This would also allow a much earlier test of NRC's process for deciding to allow emplacement of waste in a repository with no intention of retrieval than is now contemplated in DOE's repository development program. Of course, if DOE decides to construct a Test and Evaluation facility at the proposed repository site, up to 100 metric tons of radioactive material could be placed into the repository prior to the construction authorization; the rest could be emplaced afterwards.

The final phase of pre-operational testing would be a pilot stage of tests of the repository's packaging facilities. For this stage, only one or two modules of the full-scale packaging facility would be constructed and operated for a period of several years to discover and correct any design problems before constructing the rest of the modules in the facility. During this stage, several times as much material could be received, packaged, and emplaced as was used in the first two stages. Once the final designs had been modified as needed in light of this operational experience, and the full scale facilities had been completed, the research, development, and demonstration phase would be finished and the operational phase would begin.

Madam Chairman, this concludes my remarks. I would be glad to respond to any questions you might have.

BIOGRAPHICAL SKETCH

Dr. Thomas A. Cotton

Dr. Cotton has been on the staff of the Office of Technology Assessment since 1975, and has participated in many studies dealing with energy systems. He is currently directing OTA's study of the Management of Commercial High Level Radioactive Waste. Prior to coming to OTA, he was a program analyst with the Appalachian Regional Commission. He holds a B.S. in Electrical Engineering and a Ph.D in Engineering-Economic Systems from Stanford University, and an M.A. in Philosophy, Politics, and Economics from Oxford University.

Mrs. BOUQUARD. Thank you very much, Dr. Cotton.

On page 9 of your testimony, I notice that you recommended that the activities of the E-MAD facilities be expanded to develop and demonstrate waste handling capacity. Do you not think it is a little bit early in the repository development process to begin the demonstration of large-scale handling processes? What sort of testing are you talking about there?

Dr. COTTON. If it were decided that the E-MAD facility was in fact the appropriate one, the initial phase could involve several hundred tons, perhaps using the dry storage R&D program, to gain small-scale experience that would be useful for developing the designs for a full-scale repository. Granted, it may not be appropriate to start that in this year or the next year, but we feel it is necessary to start planning now to decide when it is necessary to have that experience so it can be applied to the design of a full scale facility.

Mrs. BOUQUARD. Because you feel there is a lack of experience in handling it?

Dr. COTTON. At this stage.

Mrs. BOUQUARD. But you are recommending this on a smaller scale?

Dr. COTTON. The initial phase that we would see taking place could be on the order of several hundreds of tons. That is within the scale contemplated for the dry storage R&D program.

Mrs. BOUQUARD. But do you not think it is still a little bit too early for that phase of it?

Dr. COTTON. It may be too early to begin it immediately. We think it is not a bit too early to plan and develop an integrated plan that shows when that information will be needed so that it can be provided.

Mrs. BOUQUARD. Is that not part of the mission plan?

Dr. COTTON. Exactly.

Mrs. BOUQUARD. You mentioned $5 million for the preparation of the mission. Are you suggesting this committee ought to designate $5 million for the preparation of the mission plan?

Dr. COTTON. I am not sure what the appropriate amount will be for the mission plan for the nuclear waste program. That is why I suggest you might consider drawing on some NASA expertise to deterimine what is needed for an effort of this scale. We used NASA expertise ourselves in doing the failure analysis in our program. We worked with Dr. Edgar Mitchell, who was a member of the Apollo 14 crew. We found it extremely helpful to work with someone who is thoroughly familiar with that type of planning approach. That might be a good way to determine what is an appropriate level for this program.

Mrs. BOUQUARD. I was a little bit curious about the activities and the funding level that you would recommend for R&D on repository operational facilities; I think you refer to this activity on page 6 of your testimony. Would you elaborate a little bit more.

Dr. COTTON. On page 6, I was simply pointing out examples of the kind of rates that would have to be achieved when you plan to operate a waste management system at full scale, drawing a contrast between the very limited experience we have now and the rate that will have to be attained at full-scale operation. That was a justification for a well-thought-out program for developing the necessary techniques and technologies before we try to operate the system at full scale.

Mrs. BOUQUARD. What sort of funding would you recommend?

Dr. COTTON. Again, I think that has to be addressed and developed in the mission plan.

Mrs. BOUQUARD. Thank you very much.

Mr. Ottinger?

Mr. OTTINGER. No questions.

Mrs. BOUQUARD. Mr. Lundine?

Mr. LUNDINE. First of all, I would like to thank you for your really excellent and helpful testimony. Did I understand your answer to the Chair that you do not know how much money in the next fiscal year should go toward forming the mission plan?

Dr. COTTON. Yes; I think the order of magnitude would be more than $1 million, just based on our own experience with our study and discussions with NASA. We would suggest asking the people who are experts in mission planning what really would be required for that effort. As I observed in my testimony, though, there is no evidence in the budget submission of any substantive emphasis on the mission planning effort that is commensurate with what we think is the importance of the mission plan.

Mr. LUNDINE. As I understand it, you think it would be helpful for DOE to request that NASA detail some personnel to this effort?

Dr. COTTON. That is certainly an interesting possibility. They may have mission planning people from planetary missions who are not fully occupied at this point, and that might be a way to help get the effort off on the right foot.

Mr. LUNDINE. On a related question, when Dr. Morgan testified before us last week, he indicated that he thought they could develop the mission plan in-house with existing resources. In your judgment, does that raise concern that they may not be placing adequate emphasis on it, or could you elaborate on what management steps could be taken or should be taken by DOE in the near future to address the mission plan?

Dr. COTTON. I think Dr. Morgan's statement may indicate a difference in view as to how important the mission plan is. I think that what is needed in the near term is that some serious attention be paid very quickly to what sort of an effort will be required internally. I agree with Dr. Draper that the Department is faced with so many near-term deadlines that they may simply be putting this off a bit because the first deadline is 15 months from now.

Mr. LUNDINE. The testimony on page 9 of your written statement is very interesting, and it gets at something that I thought all along was necessary as a sort of an intermediate scale facility. I am intrigued by the suggestion that maybe this can be done within existing regulations. Do you know of any discussions between DOE and NRC regarding this possibility?

Dr. COTTON. No, I do not.

Mr. LUNDINE. Thank you very much.

Mrs. BOUQUARD. Thank you very much. Mr. Chandler?

Mr. CHANDLER. No questions.

Mrs. BOUQUARD. Dr. Cotton, thank you very much for your excellent testimony. We appreciate your being with us.

Our third and last witness on the DOE's nuclear waste management budget is Dr. Raul Deju, director of the basalt waste isolation project of Rockwell International Corp., the Department of Energy's nuclear waste operating contractor at the Hanford Reservation. Dr. Deju has also previously testified before this committee, back in May 1979. It has been about 4 years since you have been with us. We welcome you back. I believe that you may also be a constituent of Representative Chandler, and I am sure he welcomes you here as well. You may summarize your statement or proceed as you wish.

STATEMENT OF RAUL A. DEJU, DIRECTOR, BASALT WASTE ISOLATION PROJECT, ROCKWELL INTERNATIONAL CORP., RICHLAND, WASH.

Dr. DEJU. Madam Chairman, thank you very much. I will summarize my statement, but I would like permission to enter the full text in the record.

Mrs. BOUQUARD. Without objection, your entire statement will be made a part of the record.

Mr. DEJU. The basalt waste isolation project, as many of you know, is part of the national effort by the U.S. Department of Energy to identify sites which are suitable for a nuclear waste repository. Our mission to date has been to assess whether or not a nuclear waste repository can be sited in the basalts beneath the Hanford site in south central Washington State.

This is not a new program. In fact, as far back as 1957, the National Academy of Sciences recommended that basins that were hydrologically isolated be drilled and tested to determine their adequacy for long-term storage of radioactive waste. As part of that program at Hanford, work was undertaken in the period from 1968 to 1972 to examine that possibility. A number of holes were drilled, and primary emphasis was placed on understanding the hydrology of the Hanford site.

After these early studies, it was determined that many types of geologic media throughout the United States should be studied as part of a national broad-based program. In 1976, as you all know, the national waste terminal storage program was instituted by the U.S. Department of Energy—the Energy Research and Development Administration at that time. This program has provided the research and development needed to support not only the basalt studies but also salt, tuff, granite, and other media. As part of the program since 1976, the basalt studies have received additional funding, and we have been very actively looking at the feasibility of constructing a repository in basalt, not only based on a thorough analysis of technical data, but also based on institutional factors, economics, and social information.

As a result of the passage of the Nuclear Waste Act on January 7, 1983, a step-by-step process has been established by which the President, the Congress, the affected individual States, the U.S. Department of Energy, and other Federal agencies can work together in siting, constructing, and operating a high-level nuclear waste repository.

The Department is required by section 116(a) of the act to identify States having potentially acceptable sites for a waste repository. A potentially acceptable site is defined in the act as:

> Any site at which, after geologic studies and field mapping but before detailed geologic data gathering, the Department undertakes preliminary drilling and geophysical testing for the definition of a site location.

As I have mentioned before, our site characterization has been ongoing since 1968. Based on the information acquired through the effort to date, we believe that Hanford contains a potentially acceptable site. Secretary of Energy Hodel notified Gov. John Spellman of Washington of this conclusion in a letter on February 2, 1983.

I want to clarify for this committee a few of the results of these studies which have led to identifying not only the advantages of siting a repository in basalt but also some of the concerns and the issues. I also would like to highlight some of these concerns for you today.

First, I would like to begin by talking a little bit about some of the favorable attributes of basalts. Basalt rocks beneath the Hanford site are unlike any other basalt in the world. In fact, they are extremely thick. They are the thickest accumulation of continental basalts found. This thickness is due to the conditions under which they were formed. The creation of massive lava flows that traveled for hundreds of miles in many cases, one lying directly on top of the previous flow. In fact, these flows at the Hanford site are in excess of 10,000 feet in thickness. The process of accumulation continued essentially uninterrupted from 15 million to about 8 million years ago.

The terrain over the area being considered for a potential repository is extremely flat. The deep basalts underlying this area are also flat, and this is a very favorable factor because it makes construction easier and it gives you a uniformity that enhances predictability. In addition, the Hanford site is located in a seismically stable area. There are no major fault zones in the area being considered for a nuclear waste repository. The physical and chemical conditions in potential repository layers in these basalts are also highly suitable for nuclear waste canister stability. In fact, in basalts in the State of Michigan, which are very similar to the basalts at Hanford, it has been known that native copper deposits have existed undisturbed in excess of 500 million years. Corrosion in a basalt environment is minimal. Because of this low corrosivity and the low solubility by which materials could be brought into solution, the environment there is very conducive to the survivability of simple waste canisters. Let us understand that the waste canister is a big cost component of the repository and a big barrier of a repository. Because of the existing geochemical conditions, very few radionuclides can go in solution, even under adverse conditions, and those few nuclides would move very slowly in the ground water environment.

It is known that in many areas of the world, ground water can move through fractures in basaltic-type terrain, and this was one of the concerns that we had earlier in the program. However, the fractures in the deep basalt beneath the Hanford site are filled with many other minerals. Hydrologic testing, in fact, has shown that these basalts with their filled fractures have permeabilities as much as 1,000 times less than those permeabilities of concrete, such as you would see in the concrete in Hoover Dam or other major dams.

I have, for the record, two samples of the basalts that I will leave with the subcommittee, one showing a fractured sample with a filled fracture and one showing the type of rock you find in the layers that we are considering for a nuclear waste repository. As the subcommittee can see, the fractures in these samples are healed, and they are no more permeable than the initial matrix of the basalts.

I have mentioned for the benefit of the committee some of the favorable attributes. I do not want to leave you with the picture that the basalts are perfect by all means, and I want to include in my testimony some of the concerns that we have at the Hanford site. We feel it is important that a sound program be continued in order to eliminate these concerns or confirm that Hanford should not be a site for a nuclear waste repository.

Three major concerns at the Hanford site have been identified. One is a thorough understanding of the ground water hydrology beneath the Hanford site, which is needed to assure that a repository in basalt will not contribute unacceptable amounts of contaminants to the accessible environment. Two, our ability to construct a repository shaft and a network of tunnels need to be fully demonstrated through an exploratory shaft program. Three, our ability to ultimately seal the repository, such that its integrity and the isolation of the waste are guaranteed, needs to be demonstrated.

Our program is aimed at addressing these concerns. In fact, the results of studies to date, as well as a complete description of planned programs to address these concerns, has been included in a document entitled "The Site Characterization Report," which was transmitted by the Department to the Nuclear Regulatory Commission in November 1982 and is now being studied by the Nuclear Regulatory Commission.

There are two fundamental areas I would like to stress about this program, because they address the major concerns I just mentioned. First of all, we have a very active program of hydrologic investigations. This program has involved expenditures of approximately $70 million to date and will require an additional $30 million expenditure before it is completed. These hydrologic studies are coupled with extensive modeling studies and with the working of a very active task force which was established last year. This task force involves various national laboratories, as well as the U.S. Geological Survey, and it is headed by Lawrence Berkeley Laboratory.

The workings of this task force are aimed at achieving closure in the hydrology issues. The task force is actively working toward resolving different points of view regarding the hydrology of the Hanford site and the implications thereof. Recent meetings of this task force, as late as last January, have been extremely encouraging, and I am optimistic that we can achieve closure of these issues in the very near future.

In addition, an active program of underground exploration, including construction of an exploratory shaft at Hanford, is planned. This program is aimed at studying the actual strata that are being considered for a nuclear waste repository, over 3,000 feet beneath the ground surface.

In addition to those two major programs, the basalt waste isolation project is making progress in the preparation of the various documents required by the Nuclear Waste Policy Act of 1982. The screening guidelines for a nuclear waste repository were published in the Federal Register this past month. A draft environmental assessment for the basalt waste isolation project's site characterization activities, as required by the act, is being issued this week. Hearings on the screening guidelines and the characterization process are being scheduled for March 21 and March 25, 1983, respectively, in the State of Washington.

All elements of the program at this time are aimed at permitting a site recommendation regarding a repository in basalt in fiscal year 1987, as called for in the act. However, I want to caution that the program scheduled to achieve this is extremely tight and is going to require an extensive, concerted effort and many parallel activities designed to maintain all its components on schedule and to achieve the dates called for in the act.

Approximately $225 million will have been spent on the basalt waste isolation project to the end of this current fiscal year. The total anticipated expenditure carrying us to the end of fiscal year 1987 is an additional $275 million, to a total of $500 million, to the point of a license application.

I would like to conclude by reiterating an earlier statement that at this time we have found no impediment to siting a nuclear waste repository in basalt. However, a number of issues remain and additional work must be done in order to resolve areas of concern. I am confident that completion of this work will provide the data needed to make a sound decision regarding the Hanford basalts.

I would like to add, for the interest of this committee, in the area of the test and evaluation facility, that at Hanford, as part of the DOE activities, we are at this time evaluating where a test and evaluation facility fits in the overall schedule and the overall project scheme. The test and evaluation facility can be a part of the whole program, and we are looking at whether a colocated or noncolocated facility is recommended. At this time, we feel that one can obtain some operating experience from a test and evaluation facility, and in the next few months we will be refining the actual scope of that program.

This concludes the text of my statement, and I would be happy to answer any questions, Madam Chairman.

[The prepared statement of Dr. Deju follows:]

RHO-BW-SA-293 P

TESTIMONY BY DR. RAUL A. DEJU
BASALT WASTE ISOLATION PROJECT
BEFORE THE
SUBCOMMITTEE ON ENERGY RESEARCH AND PRODUCTION
COMMITTEE ON SCIENCE AND TECHNOLOGY
UNITED STATES HOUSE OF REPRESENTATIVES
WASHINGTON, D.C., MARCH 2, 1983, 9:30 A.M.

Madam Chairman. I appreciate this opportunity to appear before the Committee today.

The Basalt Waste Isolation Project is part of the National effort by the U.S. Department of Energy to identify sites suitable for a nuclear waste repository. Our mission is to assess whether or not a nuclear waste repository can be sited in the basalts beneath the U.S. Department of Energy's Hanford Site. This site is located in south-central Washington State.

As far back as 1957, the National Academy of Sciences recommended that basins that were hydrologically isolated be drilled and tested to determine their adequacy for long-term storage of solidified radioactive material. Since that decision, the basalts underlying the Hanford Site have been studied extensively for this purpose. As part of that recommendation, an existing deep borehole, south of the Hanford Site, was tested hydrologically. This deep borehole was used to identify whether or not the deep basalts adjacent to and within the Hanford Site were suitable for radioactive waste storage. As a result of the information obtained from the borehole studies, funding was provided from 1968 through 1972 to drill several additional holes in the Hanford Site to further characterize the underlying basalts.

Four of the deep holes drilled in basalt between 1968 and 1972 were to depths in excess of 3,000 feet and served to obtain rock core samples and information about the hydrology of the deep strata. Such hydrologic testing indicated that the basalts beneath the Hanford Site are of very low permeability and would likely be suitable for isolating and confining solidified radioactive waste materials.

After these early studies, it was determined that many types of geologic media throughout the United States should be studied under a systematic, broader based program. Therefore, in 1976, the National Waste Terminal Storage Program was established by the U.S. Department of Energy to provide the research and development needed to support the assessment of suitability of several rock formations, including salt, tuff, granite, and basalt, as a nuclear waste repository. Sites containing these rock types are located throughout the United States. As part of this National program, the basalt studies received additional funding, with emphasis on assessing the feasibility of constructing a nuclear waste repository in basalt based on a thorough analysis of technical, economical, and social factors.

On January 7, 1983, as you know, President Reagan signed into law the Nuclear Waste Policy Act of 1982. This Act establishes a step-by-step process by which the President, the Congress, the affected individual States, the U.S. Department of Energy, and other Federal agencies can work together in siting, constructing, and operating a high-level nuclear waste repository. The U.S. Department of Energy is required by Section 116(a) of the Act to identify States having potentially acceptable sites for a waste repository. A potentially acceptable site is defined by the Act as:

> "Any site at which, after geologic studies and field mapping but before detailed geologic data gathering, the Department undertakes preliminary drilling and geophysical testing for the definition of site location."

As I have mentioned, site characterization work at Hanford has been ongoing since 1968. Based on the information acquired through the effort to date, we believe that Hanford contains a potentially acceptable site. Secretary of Energy Hodel notified Governor Spellman of Washington of this conclusion on February 2, 1983.

The studies to date that led to this conclusion have not revealed any technological impediment to siting a nuclear waste repository in the basalts beneath the Hanford Site. In fact, the basalts show many favorable attributes.

The basalt rocks beneath the Hanford Site are unlike any other basalt in the world, in that they are extremely thick. This thickness is due to the conditions under which they were formed -- the creation of massive lava flows, one lying directly on top of the previous flow. This process of accumulation continued essentially uninterrupted millions of years ago until more than 10,000 feet of basalt rock had accumulated.

The terrain over the area being considered for a potential repository is basically flat. The deep basalt flows underlying this area are also flat lying, and the thickness of individual flows remains uniform over distances on the order of 40 miles. Such flatness and uniformity enhance our ability to predict the continuity of these flows and makes construction easier.

The Hanford Site is also located in a seismically stable area. There are no major fault zones in the area being considered for a nuclear waste repository.

The physical and chemical conditions in potential repository layers in these basalts are highly suitable for nuclear waste canister stability. In addition, the solubility rate of any waste materials, which through premature canister breach could reach the groundwater, is extremely low. Because the solubility is so low, any leaching of the solid nuclear waste would be extremely slow. The few radionuclides that would go into solution in the groundwater also would move very slowly, decreasing in concentration as they decay along the flow path.

In some areas of the world, groundwater can move through fractures in basalt. However, the fractures in the deep basalts beneath the Hanford Site are filled with other minerals. Hydrologic testing has shown that these basalts, with their filled fractures, have permeabilities as much as 1,000 times less pervious than the concrete used in structures such as major dams.

I have mentioned a number of favorable attributes associated with the basalts underlying the Hanford Site; however, I also want to inform you about concerns that need to be resolved to either confirm or eliminate the basalts as a potential nuclear waste repository host medium. Three key concerns have been identified. They are:

- A thorough understanding of the groundwater hydrology beneath the Hanford Site is needed to assure that a repository in basalt will not contribute unacceptable amounts of contaminants to the accessible environment.
- Our ability to construct a repository shaft and a network of underground tunnels needs to be fully demonstrated through an exploratory shaft program.
- Our ability to ultimately seal a repository, such that its integrity and the isolation of the waste are guaranteed, needs to be demonstrated.

A comprehensive program that addresses these concerns is presently under way. The results of studies to date, as well as a complete description of planned programs, have been included in the Site Characterization Report that was transmitted to the U.S. Nuclear Regulatory Commission in November 1982. Two fundamental areas of our program that address the major issues I just mentioned include:

- An active program of hydrologic investigations that has involved expenditures of approximately seventy million dollars to date and will require expenditure of an additional thirty million dollars prior to the potential submittal of a license application for construction of a repository in basalt. These hydrologic studies are coupled with extensive modeling studies and with the workings of an active task force over the last year involving various National laboratories as well as the U.S. Geological Survey. This task force is working toward resolving different points of view regarding the hydrology of the Hanford Site. Recent meetings of this task force have been very encouraging.

- An active program of underground exploration that includes construction of a 6-foot finished-diameter exploratory shaft to repository depths and a network of underground tunnels to provide access to the subsurface, such that one can study the actual stratum being considered for a nuclear waste repository. This program would serve to demonstrate the constructibility of such a facility and would provide the space needed to conduct various scientific and engineering tests prior to the potential submittal of a license application. Sealing tests will likely be conducted in this facility.

In addition, the Basalt Waste Isolation Project is making progress in the preparation of the various documents required by the Nuclear Waste Policy Act of 1982.

The screening guidelines for a nuclear waste repository were published in the Federal Register this past month. A Draft Environmental Assessment for the Basalt Waste Isolation Project's site characterization activities is being issued this week. Hearings on the screening guidelines and the siting process are being scheduled for March 21 and March 25, 1983, respectively.

All elements of the Basalt Waste Isolation Project are aimed at permitting a siting recommendation regarding a repository in basalt in fiscal year 1987, as called for in the Act. However, the program scheduled to achieve this is extremely tight and is going to require extensive effort to maintain all its components on schedule to achieve the dates called for in the Act. Approximately two hundred twenty-five million dollars will have been spent on the Basalt Waste Isolation Project through the end of this fiscal year, with a total anticipated expenditure of five hundred-fifty million dollars through the potential submittal of a license application at the end of fiscal year 1987.

I will conclude by reiterating my earlier statement that at this time no impediment to siting a nuclear waste repository in basalt has been found; however, additional work remains to be done to resolve areas of concern. I am confident that completion of this work will provide the data needed to make a sound decision regarding the Hanford basalts.

This concludes the text of my prepared statement. I would be happy to answer any questions at this time.

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Mrs. **Bouquard**. Thank you very much. We would like to hear from you further on your opinion as to whether or not the T&E facility should be colocated or not colocated with the repository.

Dr. **Deju**. As I said, we are in the process of evaluating that question. At this time, we feel that a colocated test and evaluation facility would have more advantages than a noncolocated facility. But the real value of the test and evaluation facilities is in obtaining operating experience, rather than in gathering data at depth. We feel that with the present schedule, we can gather the data for site characterization best through the exploratory shaft program and through bore holes and other studies and we can gather operating experience in the test and evaluation facility.

Mrs. **Bouquard**. You mentioned that there were some issues that remained to be resolved regarding the suitability of the Hanford site, but you also stressed the favorable characteristics of the site. Am I correct, that you feel the Hanford site is probably suitable to host a repository?

Dr. **Deju**. Our preliminary assessment, using performance analysis models, shows that we have an adequate margin of safety. We want to be sure that we have gathered the best possible data and understand the hydrologic system as best as one humanly can before we make a final assessment of its performance. We also want to emphasize that the system is one of redundant multiple barriers, and the waste package, the seals, and the site all complement one another. We feel that with the three systems, one has an excellent margin of safety for a nuclear waste repository.

Mrs. **Bouquard**. I gather from your testimony that you feel like the fiscal year 1984 proposed repository program is going to be principally an R&D program?

Dr. **Deju**. The program in the next few years is principally an R&D program. As you go into the 1986 and 1987 time frame, you get more into the design considerations and finalizing the design for a repository.

Mrs. **Bouquard**. Do you feel that the proposed program activities are properly allocated between the waste fund and the Federal appropriations?

Dr. **Deju**. I feel they are properly allocated. I caution that the schedule is extremely tight.

Mrs. **Bouquard**. Are there any R&D activities at the Hanford Reservation that are not funded through the nuclear waste fund?

Dr. **Deju**. In 1983 we have some R&D activities that are not funded by the nuclear waste disposal fund, and those are primarily in the waste package area.

Mrs. **Bouquard**. Turning to waste and spent fuel packaging, are your efforts in this area directed to minimizing handling as well as the cost to the taxpayer? For instance, are you looking at the storage, transportation, and disposal in one canister, or are you looking at separate canisters? How are you directing your activities?

Dr. **Deju**. There are advantages to both minimizing cost and minimizing handling. Both of those are prime components of the program leading toward the design of a waste package. In the area of minimizing handling, you want to make sure that you minimize changes to the canister from transport to disposal.

Mrs. **Bouquard**. You are looking at the one-canister concept?

Dr. **Deju**. We are looking at the one-canister concept, as well as minimizing cost. Both of these.

Mrs. **Bouquard**. Thank you very much.

Mr. Ottinger?

Mr. **Ottinger**. Thank you, Madam Chairman.

I would like to get a little better understanding of the degree of concern that you state on page 4 of your statement. Is there any indication that the ground water hydrology underneath the Hanford site will be such an impediment to locating a repository there that the site would have to be abandoned?

Dr. **Deju**. I do not believe so, Mr. Ottinger. Let me clarify that statement a bit. The horizon that we are looking at for a nuclear waste repository is one where we have approximately 250 feet of thickness of a rock quality of the type I showed you in the sample I furnished the subcommittee. The closest water-bearing strata to the center of that horizon is several hundred feet above the top of that layer. That particular water-bearing strata is capable of producing small quantities of water. Our preliminary calculations—and not just our own calculations, but calculations by all the people, including the U.S. Geological Survey and various other agencies that have done calculations—show travel times in the order of 13,000 years plus. Those are well in excess, at least 13 times greater than required by the EPA regulations. With recent data, our latest numbers go as high as 80,000 to 90,000 years.

So we feel that we have an adequate margin of safety in the hydrology. Our desire is to understand the hydrology of the site, as best as one possibly can, so that we know to the best of our ability what that margin of safety is.

Mr. **Ottinger**. Will digging a major shaft at the site contribute to your knowledge with respect to the hydrology?

Dr. **Deju**. Drilling a shaft would contribute greatly to our understanding of the hydrology, because it provides not only access to the layer being considered for a repository, but would permit you to put portholes on the side of the shaft at various layers, and you drill horizontally through these portholes to understand the hydrology of all those overlying layers. We have those provisions in the program.

Mr. **Ottinger**. Are you seeking a waiver of completion of the environmental assessment and the hearings required under the act?

Dr. **Deju**. As noted in my testimony, the draft environmental assessment which was issued covers the screening guidelines which have also been issued as they apply to the Hanford site. That is in accordance with the clause on the expedited program in section 112 of the act. The hearing will be held on March 25 in Richland, prior to the big-hole drilling activities at Hanford.

Mr. **Ottinger**. You called it a draft environmental assessment. What is lacking?

Dr. **Deju**. A draft environmental assessment is prior to the public hearing.

Mr. **Ottinger**. All the data that would be required for that assessment has been accumulated, and it is only in draft because the hearings have not yet been held?

Dr. **Deju**. That is correct.

Mr. **Ottinger**. I have nothing further.

Mrs. **Bouquard**. Thank you very much, Mr. Ottinger.

Mr. Chandler?

Mr. **Chandler**. You are not actually a constituent; you are a neighbor.

Again going to page 4 of your testimony, which is obviously of great interest to the subcommittee, and to ask a question I know our chairman is interested in also, you are suggesting here that funds are insufficient to accomplish your task on time. You talked about the time schedule being tight. Is there need for more funds in fiscal year 1984? Is that the point you are making?

Dr. **Deju**. No. The funding is very well allocated. The reason I am mentioning that is, as you know, there are many provisions in the act. There are many reports that have to be prepared. There are many steps in the whole process. As was pointed out by one of the presenters earlier, this is the first repository that we are building. We have never built such a repository. So it is a difficult process, and it is a very short, compressed schedule. The act actually compressed our earlier plans by about 18 months, so we are going to have to work expeditiously to get there. It is not a matter of putting in additional resources. It is a matter of keeping all elements of the program in line to be sure that you achieve the end in a timely fashion.

Mr. **Chandler**. I think members of this subcommittee may be interested in something that has nothing to do with ground water or salt or anything else, but that is the attitude of the people who live in the tricities area in the State of Washington toward the word "nuclear industry" and how they feel about some more of it located in their area.

Dr. **Deju**. I think generally there is support in the tricities for the nuclear industry, but this support comes as a result of understanding the problems related to the nuclear fuel cycle and of understanding the industry as a whole. We also have had a very active R&D program in this area, as I noted, since 1968. In fact, there are about 500 scientists and engineers that are presently working on this program, representing many companies in the Washington area, including many of Washington's major universities. So that understanding leads you to a more comfortable situation with the basalts.

Mr. **Chandler**. Thank you.

Mrs. **Bouquard**. Thank you very much, Mr Chandler.

Thank you very much, Dr. Deju, for your excellent testimony. We look forward to hearing from you later in the year.

The next portion of our hearing will consist of a panel of witnesses who will testify on the nuclear fuel cycle R&D program. The witnesses for this portion are Mr. John Gray, who is chairman of the International Energy Associates, Ltd., and Mr. Vincent Boyer, who is senior vice president for nuclear power, Philadelphia Electric Co.

We welcome you, gentlemen, to our hearing today. We have your complete statement, and you may summarize it as you wish. Your entire statement will be made a part of the record.

We are also very happy to have the Honorable Mike McCormack with us today. He is the former chairman of this committee to whom we still look for valuable expertise. We are always happy to have you here with us.

Mr. Gray, proceed.

STATEMENT OF JOHN E. GRAY, CHAIRMAN, INTERNATIONAL ENERGY ASSOCIATES, LTD., WASHINGTON, D.C.

Mr. **Gray**. Thank you, Madam Chairman.

Madam Chairman and members, I am pleased to appear before you today to testify on reprocessing of nuclear fuels and particularly on the issue of the Barnwell nuclear fuel plant. I understand that the interest of the subcommittee is in obtaining information which can be used as a basis for establishing long-range policy, as well as further strengthening safeguards against diversion.

Our company has been active in the last few years on these issues as consultants to the Government and various private organizations. These and other interests led to the preparation in June 1982 of a paper for the Atomic Industrial Forum, titled "An Assessment of Reinstituting Reprocessing of Civilian Nuclear Fuel in the U.S." The basic question considered was what it would take on the part of Government and industry to get reprocessing going. I authored that paper in 1982 and will draw from it in my remarks today.

I would first like to present updated portions of the executive summary and recommendations of the paper, which went on to say that the demonstration of commercial-scale reprocessing should be recognized as one of the precursors to and elements of the U.S. national policy which would assure the procurement of additional light-water reactors and eventually of fast breeder reactors as electric power load growth and generation economics dictate. Other precursors and elements of such a policy are establishing spent fuel transportation and radioactive waste management systems, as well as predictable licensing requirements for all nuclear power activities and the ability to finance them.

Looking at earlier reprocessing initiatives, and Barnwell specifically, dramatic changes in regulation and public policy were principally responsible for impairing earlier reprocessing initiatives. This led to the U.S. nuclear utilities supporting alternative solutions for storage and disposal of spent nuclear fuel, just as the Reagan administration began to encourage reinstitution of commercial reprocessing.

The issues related to reprocessing continue to be the need for reprocessing, the need for spent fuel storage away from reactors, radioactive waste disposal, nonproliferation and foreign policy, Federal/State relations, public acceptance, private/public-sector ownership and operations, and financial regulatory and public policy. An important related issue still is reprocessing for the FDR fuel cycle.

Consideration of both Government and industry roles at that time led to the conclusion that the U.S. Government must play a dominant role in the institution of commercial reprocessing in order for the nuclear industry and nuclear utilities to be forthcoming with realistic initiatives. As well, the U.S. Government would have had to provide for any appropriate foreign participation.

In that same paper, options were presented for accomplishing reinstitution, as well as other front-end and back-end fuel cycle operations which might be usefully combined under given institutional frameworks dealing with the question that was raised in the earlier part of this session.

The principal conclusions that were presented in this paper last June were that there is neither the need nor a valid economic basis for deciding now that all spent fuel from all U.S. light-water reactors should be reprocessed. However, there are important incentives which dictate the need for some civil reprocessing within the United States. These include spent fuel congestion, which will be experienced by some but not all U.S. reactors, beginning in the mid-1980's; prospective demand for plutonium for breeder research development and demonstration; a need to develop and demonstrate reprocessing as a step in one of the alternate ways of managing nuclear waste; that is fission product isolation, vitrification, and disposal, not unimportantly, a need to regain international leadership in developing reprocessing technology and related safeguards techniques as an essential element in the achievement of U.S. nonproliferation and other international nuclear policy objectives.

Reprocessing of civil power reactor fuel must be developed and demonstrated on an industrial scale as an integral part of breeder reactor development and demonstration. Without reprocessing, there is no breeder option. Finally, the lead times for the development and demonstration of industrial-scale reprocessing are of the same order as those for breeder reactors themselves. Therefore, this process must get underway soon.

The position which was presented is that when taken together, these considerations constitute a convincing case for proceeding now with a major development and demonstration of industrial-scale reprocessing. One further consideration made this option compelling, in that the Barnwell Nuclear Fuel Plant is available as the nucleus of the effort, and there are attendant large savings in cost and time consonant with the use of Barnwell.

The assessment also led to a recommended action plan, which appeared to some to make sense at that time on what one does to get reprocessing going. I will not repeat that plan. Suffice it to say that this recommended action plan would not have guaranteed that reprocessing got going. However, the adoption of such an action plan would have led to the practical tests of the initiatives, negotiations and agreements that would have been the necessary precursors to a viable commercial enterprise.

All of the foregoing had to do with getting Barnwell up and running. Before commenting on the realities of these earlier recommendations as I see them today, I would like to bring to your attention additional options from the same paper relevant to the reinstitution of civil reprocessing. One option is to build on legislation such as the Nuclear Waste Management Act and provide an additional or legislative basis for planning, financing, and executing all back-end operations away from reactors, including transportation, AFR storage, reprocessing, byproduct recovery, radioactive waste processing, and long-term radioactive waste management.

An additional option is to create a self-financing U.S. Government authority to plan and carry out those activities. Alternatively, one could create a self-financing U.S. Government corporation to plan and establish the activities, along with the purpose of having them revert to being commercial activities within specified time frames, except where there are compelling reasons which preclude reversion. The charter of such a corporation could provide for nuclear utilities to be represented on the board of directors, along with other presidential appointees. Or, one could create a Federally chartered private U.S. corporation, empowered to plan, finance, and carry out the activities mentioned above. Such a private corporation could be responsible for these activities, as mandated by law, and financing could be based on charges made against the nuclear utilities on the basis of nuclear energy capacity or energy sales, or both.

I will not further develop that concept, except to say that it is there and conceptually could be further developed. Finally, all of these activities could be extended to include nuclear fuel cycle front-end operations, especially enrichment. My own opinion is that the conduct of the enrichment activities in the United States could and should be put on a significantly more business-like basis, either within the Government or outside the Government, than is now the case.

I would like now to present the situation as I see it today and what might be done.

First, I would say that notwithstanding the technical and political need to develop a civil reprocessing capability, there is little or no current serious investment-type interest on the part of either the Government or the nuclear industry in reprocessing, at Barnwell or anywhere else. Next, I would say that passage of the Nuclear Waste Policy Act further diminishes near-term interest in reprocessing on the part of some nuclear utilities, if not most nuclear utilities.

I would also offer that while near-term requirements for plutonium are nonexistent for thermal recycle and a bit uncertain for FBR's, reprocessing continues as an ultimately necessary operation in the nuclear fuel cycle for all the historic technological and economic reasons that I have cited. Also, nonproliferation and safeguards of peaceful nuclear activities continue as increasingly important concerns of all nations. The United States cannot expect to have significant influence on how reprocessing plants are safeguarded, or on the international means of safeguarding plutonium, if it is not an active participant.

Barnwell continues as a solution in search of a home and the right problems. The right problems in today's environment in my opinion are spent fuel storage research, development, and demonstration of reprocessing; uranium and plutonium recovery; radioactive waste products preparation; and the economics of all of the foregoing; and improved nonproliferation and safeguards practices, both for use at Barnwell and for export as we cooperate with other nations on nonproliferation.

The right home for Barnwell, in my opinion, is the DOE. Barnwell may be available as a gift, if the Federal tax consequences of demolition can be preserved. I have to say that a representative of the present owners of Barnwell yesterday said to me, "John, please distinguish between a gift and a writeoff related to demolition." I asked why, and the response was, "If it's a gift, we could hope to get present market value as the value of the writeoff. That is a different figure than that associated with demolition."

If Barnwell were accepted as a gift, Barnwell could be leased to a nuclear industry consortium which could then upgrade the facility and carry out spent fuel storage, reprocessing and rad-waste concentration programs. The right primary source of facilities upgrading and R&D funds is probably DOE, with the nuclear waste fund being a possible additional source. A major source of funds for operations could result from charges to nuclear utilities which contract for reprocessing services, where reprocessing costs may be offset by the value of recovered uranium and by avoidance of the costs of spent fuel storage. If there is no market for the plutonium, it could be given to the U.S. Government. This may be possible because of the overall economics associated with this facility, with its historic low costs. If there are FBR-related demands for plutonium, it could be sold at "market" and credited to the Barnwell operation.

This is one way to go. It is not a novel concept that I am expressing here today. It is a collection of thoughts that have been and are being considered by various parties, with no assurance that the package is going anywhere.

However, in closing, I would like to emphasize that while a full-blown commitment to commercial reprocessing is not now warranted, neither is continued misuse or abandonment of a key facility and a key technology. Long-range policy requires the demonstration of the technology, the economics, and the regulation of reprocessing, rad-waste concentration, and plutonium and uranium recovery, and the perfection of safeguards. Abandonment of Barnwell as a commercial reprocessing facility was a natural consequence of what I considered to be the Carter administration's somewhat misguided policies.

I would interpolate there that the first statement that Candidate Carter made regarding Barnwell was, I believe, before a United Nations conference in the spring of 1976. At that time he very wisely recommended the internationalization of Barnwell as a key tool for the United States to use in enhancing and advancing effective nonproliferation policies. That was subsequently abandoned, for reasons I am not particularly concerned with at this stage.

However, where the Carter administration began, the abandonment of Barnwell became a natural consequence. However, abandonment of Barnwell as the only commercially oriented spent fuel storage reprocessing and safeguards facility in the United States to me would be a most unusual consequence of the Reagan administration's policy. In fact, it would appear to me to mock that policy. As well, the long-continuing effort toward an effective nonproliferation regime, with attendant international safeguards, will not be served by Barnwell's remaining inoperable, much less being abandoned.

As I have mulled over these problems once again, it appears to me that fear by some of plutonium and its misuse in weapons continues to inhibit or prevent our getting on with demonstrating the technology and economics of its peaceful uses in ways which can be regulated and safeguarded. It is a little bit like fearing the plowshare because of the sword, and I suggest there is a difference and that we continue to work on the peaceful uses, the regulation, and the safeguarding of plutonium.

Thank you for this opportunity to appear before you again.

[The prepared statement of Mr. Gray follows:]

Statement of John E. Gray
Chairman
International Energy Associates Limited
Before The
Committee On Science And Technology
Subcommittee On Energy Record And Production
U.S. House of Representatives
March 2, 1983

Madam Chairman and Members, I am pleased to appear before you today to testify on reprocessing of nuclear fuels and particularly on the issue of the Barnwell Nuclear Fuel Plant. I understand that the interests of the Subcommittee are in obtaining information which can be used as a basis for establishing long-range policy as well as further strengthening safeguards against diversion.

Our company has been active in the last few years on these issues as consultants to the government and various private organizations. These and other interests led to the preparation in June of 1982 of a paper for the Atomic Industrial Forum titled "An Assessment of Reinstituting Reprocessing of Civilian Nuclear Fuel in the U.S.". The basic question considered was what it would take on the part of government and industry to "get reprocessing going". I authored that paper in 1982 and will draw from it in my remarks today.

First I would like to present updated portions of the Executive Summary and Recommendations of the paper:

> "The demonstration of commercial-scale reprocessing should be recognized as one of the precursors to and elements of a U.S. national policy which would assure the

procurement of additional light-water reactors (LWRs) and eventually of fast breeder reactors (FBRs) as electric power load growth and generation economics dictate. Other precursors and elements of such a policy are establishing spent fuel transportation and radioactive waste management systems as well as predictable licensing requirements for all nuclear power activities and the ability to finance them... Dramatic changes in regulation and public policy were principally responsible for impairing earlier reprocessing initiatives on the part of the U.S. nuclear industry. This led to the U.S. nuclear utilities supporting alternative solutions for storage and disposal of spent nuclear fuel, just as the Reagan Administration began to encourage re-institution of commercial reprocessing. Susequently, some renewed interest in the U.S. and elsewhere provides additional positive factors in considering how to 'get reprocessing going' in the U.S.

"The issues are: the need for reprocessing; the need for spent fuel storage away from reactors; radioactive waste disposal; nonproliferation and foreign policy; federal/state relations; public acceptance; private/public--sector ownership and operations; and financial, regulatory, and public policy. An important related issue is reprocessing for the FBR fuel cycle.

"Consideration of government and industry roles leads to the conclusion that the U.S. Government (U.S.G.) must play a dominant role in the re-institution of commercial reprocessing in order for the nuclear industry and nuclear utilities to be forthcoming with realistic initiatives, as well as to provide for appropriate foreign participation.

"A set of conditions which must be met for reprocessing to be re-instituted is as follows:

- Promotion and development of reprocessing operations by a prospective owner/operator, public or private, or 'mixed'.
- Evidence of demand on the part of the nuclear utilities and/or the U.S.G. and/or others for U.S. reprocessing services or by-products such as plutonium.
- Alternatively, an executive/legislative branch decision that reprocessing should be required as a matter of law.
- Planning of reprocessing re-institution coincidentally with other back-end operations -- especially transportation of spent fuel and radioactive waste processing and management.
- Establishment by the NRC of applicable licensing and regulation standards.
- For private owners/operators, appropriate private insurance as well as U.S.G. indemnification against non-business risks such as changes in public policy.
- Availability and operability of both reprocessing facilities and ancillary services and operations required for transportation

of spent fuel and receiving of radioactive wastes and by-product plutonium considering both federal and state policy, law, and regulation, as well as economic factors.

- Costing, pricing, contracting, and financing the reprocessing and related operations."

Options were presented for accomplishing the above as well as other front-end and back-end fuel cycle operations which might be usefully combined under given institutional frameworks.

The principal conclusions were as follows:

- There is neither the need nor a valid economic basis for deciding now that all spent fuel from all U.S. LWRs should be reprocessed.
- However, there are important incentives which dictate the need for some civil reprocessing within the United States. These include:
  - spent fuel congestion, which will be experienced by some, but not all, U.S. reactors beginning in the mid-1980s.
  - prospective demand for substantial amounts of plutonium for breeder research, development, and demonstration (RD&D).
  - a need to develop and demonstrate reprocessing as a step in one of the alternative ways of managing nuclear waste (i.e. fission product isolation, vitrification, and disposal) which is viewed as the preferable or only acceptable approach by most countries.

-- not unimportantly, a need to regain international leadership in developing reprocessing technology and related safeguards techniques as an essential element in the achievement of U.S. non-proliferation and other international nuclear policy objectives.

- Reprocessing of civil power reactor fuel must be developed and demonstrated on an industrial scale as an integral part of breeder reactor development and demonstration. Without reprocessing, there is no breeder option.

- The lead times for the development and demonstration of industrial-scale reprocessing are of the same order as those for breeder reactors themselves. Therefore, this process must get underway soon.

When taken together, these considerations constitute a convincing case for proceeding now with a major development and demonstration of industrial-scale reprocessing. One further consideration made this option a compelling one: the availability of the Barnwell Nuclear Fuel Plant (BNFP) as the nucleus of the effort, with attendant large savings in cost and time.

The assessment led to a recommended action plan which is responsive to the question of what it would take on the part of government and industry to "get reprocessing going." That recommended plan as outlined in the 1982 Study is as follows:

- Focus on Barnwell (BNFP) as a first-step opportunity to demonstrate commercial-scale reprocessing and preparation of radioactive wastes and to provide plutonium for FBRs.

- The U.S.G. should:

-- establish the ground rules for licensing Barnwell as a commercial reprocessing plant and assure a predictable and stable licensing environment. (NRC)

-- prepare a plan and agreements under which plutonium will be purchased (or accepted) from BNFP in keeping with requirements (or lack thereof) for FBR RD&D. (DOE)

-- specify the (simplest) form, means, and schedule for accepting high-level radioactive wastes from BNFP. (DOE)

-- provide indeminification or some form of assurance against investments in the BNFP becoming unproductive because of radical changes in U.S.G. policy. (DOE)

-- facilitate the ability of (foreign institutions) to participate in the completiion and use of the BNFP, if that participation is essential in financing and providing demand for reprocessing services. (DOE) (DOS)

-- encourage the U.S. nuclear utilities to commit to sufficient reprocessing services, with or without the possible (foreign) demand, to get the BNFP going. Do this is concert with relevant institutions in the nuclear industry and a group of nuclear utilities. (DOE)

-- develop a modus vivendi with the states directly involved with facilities for reprocessing itself (SC) and with transportation of radioactive material to and from the BNFP. (DOE)

- It was also recommended that the nuclear industry should develop an enterprise to promote and carry forward "private-sector" commercial reprocessing at Barnwell, in anticipation of, in concert with, or as a result of the U.S.G. initiatives recommended above. It was thought the present owners might wish to re-examine their position in light of prospective U.S.G. initiatives. If they were to participate in developing such an enterprise, they could be joined by others with announced interest, such as (foreign institutions) Bechtel and Westinghouse, as well as other companies. If the present owners choose to abandon the BNFP, the enterprise could be developed without them and provisions made for acquiring rights to the BNFP, especially in the presence of the U.S.G. initiatives above. The U.S. promoter of the enterprise should, in any event, reach out and consolidate the any (foreign) interests.*

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* Conceivably the arrangements developed for foreign participation could provide useful models for future multinational fuel cycle centers that could help discourage the establishment of small national reprocessing plants in sensitive regions.

- Finally it was proposed that a group of nuclear utilities should express their willingness to commit to sufficient reprocessing services to get the BNFP going, subject to the U.S.G. and U.S. nuclear industry actions proposed above, as well as the negotiation of contracts acceptable to them and to their state utility commissions.

This recommended action plan would not guarantee that reprocessing "gets going"; however, its adoption could lead to the practical tests of initiatives, negotiations, and agreements and possibly to a viable commercial enterprise.

All of the foregoing had to do with getting Barnwell up and running. Before commenting on the realities of these earlier recommendations, I would like to bring to your attention additional options from the same paper relevant to "reinstitution" of civil reprocessing. These are:

- Build on legislation such as the Nuclear Waste Management Act and provide an additional legislated basis for planning, financing, and executing all back-end operations, away from reactors -- including: transportation, AFR storage, reprocessing, by-product recovery, radioactive waste processing, and long-term radioactive waste management.

- Create a self-financing U.S. Government Authority to plan and carry out the activities above.

- Alternatively, create a self-financing U.S. Government Corporation to plan and establish the activities above with the purpose of having them revert to being commercial activities within specified time frames except where there are compelling reasons which preclude reversion. The charter of such a corporation could provide for nuclear utilities to be represented on the board of directors, along with (other) appointees of the President.

- Or, create a federally chartered private U.S. corporation empowered to plan, finance, and carry out the activities above. Such a private corporation could be responsible for these activities as mandated by law, and financing could be based on charges made against the nuclear utilities on the basis of nuclear energy capacity or energy sales or both. This could be a private corporation subject to economic regulation as well as regulations controlling public health and safety. Utilities could be the principal owners of such a corporation, or not, and could be strongly represented on the board of directors, or not. Provisions could be made for U.S.G. capital contributions; representation on the board, and being served by the corporation (per purchases). In establishing the corporation, consideration would be given to reserving to the U.S.G. full responsibility for any of the activities or operations which clearly could not be assigned to the private sector (perhaps custodial care of high-level waste repositories). All other operations would be the responsibility of the corporation. Use of this option would be, to a considerable degree, a derivative of the Comsat Corporation.

- Further extend the activities to include nuclear fuel cycle front-end operations, especially enrichment. Add enrichment operations in considering an Authority, a Government Corporation, or a Private Corporation. This could have material impact by virtue of adding a large on-going economic activity serving substantially the same customer base. The transfer of enrichment to a U.S. Government authority above would not change its present status as a U.S.G. operation in any significant manner; its transfer to a U.S. Government Corporation would get it one step closer to being a "commercial" operation; the transfer to a federally chartered private corporation would make it a commercial operation; and transfer to a U.S.G. or private corporation could provide for the U.S.G. to receive a substantial "payment" in cash or equity for the value of its enrichment operations. If this assumed the form of equity in a private corporation, it could provide a business-like basis for federal presence on the board of the corporation during the period that the U.S.G. continued to hold the equity. Correspondingly, the U.S.G. could be required by the necessary enabling legislation to divest itself of all ownership in a term such as 10 years. Ergo, one would achieve the long-stated policy objective that the Federal Government should "get out of the fuel-cycle business."

The options were developed in the order of their feasibility for near-term acceptance and action. Pivotal to success on any of them is coherent planning and decision making on the part of the nuclear utilities and the U.S.G. - both executive and legislative branches. They are the right way to go in the long term. The nature and history of the issues as well as precedents from other nations tend to support this premise.

The options which I have described, were developed in the order of their feasibility for near-term acceptance and action. Pivotal to success on any of them is coherent planning and decision making on the part of the nuclear utilities and the U.S.G. - both the executive and legislative branches. In my view a selection of any one of these approaches would be the right way to go in the long term. The nature and history of the issues as well as precedents from other nations tend to support this premise.

However, the history of reprocessing in the U.S. as well as the current status of other closely related institutional and technical issues make it clear that commercial reprocessing can be re-instituted in the near future only with the U.S.G.'s sustained encouragement, support, and commitments, and a matching response on the part of the nuclear utilities, as well as the nuclear industry. Success therefore will be feasible only if there is a broad base of support which is essentially bipartisan in nature.

That completes reference to my earlier thoughts on the whys and the hows of reinstitution. In addition and finally, I'd like to present the situation as I see it today, and what might be done:

1. Nothwithstanding the technical and political need to develop a civil reprocessing capability, there is little or no current serious investment-type interest on the part of either the government or the nuclear industry in reprocessing - at Barnwell, or anywhere else.

2. Passage of the Nuclear Waste Policy Act further diminishes near-term interest in reprocessing on the part of some nuclear utilities.

3. While near-term requirements for plutonium for thermal recycle are non-existent and for FBRs, a bit uncertain, reprocessing continues as an ultimately necessary operation in the nuclear fuel cycle for all the historic technological and economic reasons that I have cited.

4. Also, nonproliferation and safeguards of peaceful nuclear activities continue as increasingly important concerns of all nations. The United States cannot expect to have significant influence on how reprocessing plants are safeguarded, or on the international means of safeguarding plutonium if it is not an active participant.

5. And Barnwell continues as a solution in search of the right problems - and a home. The right problems in today's environment are: spent fuel storage; research, development, and demonstration of reprocessing, uranium and plutonium recovery, radioactive waste products preparation and their economics and improved nonproliferation and safeguards practices - for use at Barnwell and for export as we cooperate with other nations on nonproliferation.

6. The right home for ownership of Barnwell is the DOE. Barnwell may be available as a gift, if the Federal tax consequences of demolition can be preserved. Barnwell could be leased to a nuclear industry consortium which could then upgrade the facility and carry out spent fuel storage, reprocessing, and rad-waste concentration programss. The right primary source of facilities up-graading and R&D funds is probably DOE, with the Nuclear Waste fund being a possible

additional source. A major source of funds for operations could result from charges to nuclear utilities which contract for reprocessing services where reprocessing costs may be offset by the value of recovered uranium and by avoidance of the costs of spent fuel storage. If there is no market for the recovered plutonium, it could be given to the U.S.G. This may be possible because of the overall economics associated with a facility with historic low costs. If there are FBR-related demands for plutonium, it could be sold at "market" and credited to the Barnwell operation.

In closing I would like to emphasize that while a full-blown commitment to commercial reprocessing is not now warranted, neither is continued misuse or abandonment of a key facility and a key technology. Long-range policy requires the demonstration of the technology, economics, and regulation of reprocessing, rad-waste concentration, and plutonium and uranium recovery and the perfection of safeguards. Abandonment of Barnwell as a commercial reprocessing facility was a natural consequence of the Carter Administration's somewhat misguided policies. Abandonment of Barnwell as the only commercially-oriented spent fuel storage, reprocessing, and safeguards facility in the U.S. would be a most unusual consequence of the Reagan Administration's policy. In fact, it would appear to mock that policy. As well, the long continuing effort toward an effective nonproliferation regime, with attendant international safeguards, will not be served by Barnwell's remaining inoperable, much less by being abandoned.

As I've mulled over these matters once again, it appears to me that fear by some of plutonium and its misuse in weapons continues to inhibit or prevent our getting on with demonstrating the technology and economics of its peaceful uses in ways which can be regulated and safeguarded. This is like fearing the plowshare because of the sword. There is a difference, and I urge that we not stop working on plowshares.

Thank you for this opportunity to appear before you again.

JOHN E. GRAY is a Principal Consultant, Chairman of the Board, and Chief Executive Officer of International Energy Associates Limited. He is Chairman of the Board of IEA of Japan Co., Ltd. (Tokyo) and is a Member of the Board of Directors and Supervisory Board of TECOP-3H (Paris). He is a Director of: Materials Technology Corporation, GEOMET Exploration, Inc., ABACUS Controls, and Evaluation Research Corporation. He is a Director of the Atlantic Council of the United States and Chairman of its Energy Policy Committee. Mr. Gray was formerly: Energy Consultant to the Federal Government, U.S. and foreign electric utility industries, and the Ford Foundation; President of NUS Corporation; Manager, Shippingport Atomic Power Station, Duquesne Light Company; engineer/manager - Savannah River Project, U.S. AEC, U.S. Navy Naval Reactors Branch, General Electric and Westinghouse.

Mrs. BOUQUARD. Thank you, Mr. Gray, for your excellent testimony.

Mr. Boyer?

STATEMENT OF VINCENT S. BOYER, SENIOR VICE PRESIDENT FOR NUCLEAR POWER, PHILADELPHIA ELECTRIC CO.

Mr. BOYER. I am Vincent Boyer, senior vice president for Nuclear Power for the Philadelphia Electric Co. I am a past president of the American Nuclear Society and current chairman of the EEI's nuclear power executive advisory committee, and I am chairman of the AIF committee which reviews the activities at Three Mile Island.

I am pleased to submit testimony today. While John Gray and I did not collaborate on the preparation of our testimony, I believe that both of our submittals complement each other very well and concur with each other. In fact, his latter remarks basically summarize the main points in my presentation. So I will brief the material which I have submitted.

The United States has been a leader in the peaceful uses of nuclear energy. We have gone forward with the front end of the fuel cycle and the operation of the facilities, but we still have one thing lacking, and that is the demonstration of the tail-end of the fuel cycle that we process waste storage. The waste bill has taken care of the latter, so it leaves the reprocessing area on which we should concentrate.

The Philadelphia Electric Co. owns and operates two units at its Peach Bottom site in lower Pennsylvania. We also are part owners, as we are at Peach Bottom, of two units operated by Public Service Electric & Gas of New Jersey, the Salem unit, and Philadelphia Electric is currently building two units for service in 1985 and 1988 at Limerick. The units which we operate and own are boiling water reactors. In 1982, 34 percent of the energy supplied to our customers came from nuclear energy and was a major contributing factor in enabling us to reduce the fuel adjustment charge to our customers.

The fuel pools at Peach Bottom, which went in service in 1974, have been reracked once to enable them to accommodate more elements, and each of the pools with the present condition will reach their full core discharge limit by 1985. It will be necessary for us to take further steps to expand the storage capacity of the pools or to look at other options, such as dry cast or offsite storage.

The amount of fuel that will be produced in nuclear facilities will certainly be much more than can be accommodated in the AFR provisions of the waste bill—1900 tons. Peach Bottom presently has 400 tons in its pool alone.

There are several reasons why reprocessing of spent fuels should be implemented at this time, and it is appropriate that a listing be made. The first point is that it will reduce the need for supplemental spent fuel storage facilities on the part of utilities. It will not completely obviate that problem, but it will certainly assist in it. The second is that it will enable the recovery and reuse of the residual uranium. Uranium is a resource, it is partially enriched, and there is a credit for its enrichment and for its conversion.

The third is that it considerably reduces the volume, the hazard, and the cost of disposal of high-level nuclear waste material. Certainly, the fission products are only 3 percent of the volume in the fuel, and while that volume increases as a percentage of the total waste as the fuel goes through reprocessing, it still results in a considerably less volume to be stored in the repository.

By removing the uranium and plutonium, long half-life elements, you are not only saving a resource but reducing the activity over periods of time. The cost of disposal of the high-level waste is reduced because of the reduction in volume.

The fourth reason is that it will provide the technical basis for needed follow-up reprocessing plants. It is estimated that about three plants will be required to fully accommodate the industry's needs.

The fifth is to regain leadership in the world community so that we may influence international weapons proliferation controls. Without a viable reprocessing industry here in the United States, it is difficult for us to influence activities about the world.

Barnwell was built in 1970, and we are all familiar with its past history. Since 1978, congressional appropriations for R&D have supported the national energy and nonproliferation objectives at Barnwell and have been able to maintain a functioning technical staff. The safeguard system has been extensively developed there during the past several years, and the work that has been accomplished verifies that onstream security and accounting measures can be accomplished. Indications are that further support for Barnwell will be terminated by the end of July 1983. It would be tragic if alternative means cannot be developed to preserve this unique national asset.

Nuclear plants now in operation and under construction, as I mentioned, would require additional reprocessing plants, and it is virtually certain that these additional plants will not come into fruition if we do not get started.

The present administration is supportive of reprocessing as a private investment business. Industry also wants reprocessing to move forward, but it is skittish due to past governmental actions. Consequently, alternatives are being discussed, and it is hoped that Barnwell may be operated as a demonstration facility on a cooperative basis involving industry and DOE.

Such actions would enable the Barnwell plant to do the following: One, demonstrate safer, more economical nuclear waste disposal than the wasteful alternative of discarding spent fuel; two, provide definitive data for cost evaluations of fuel cycle options; three, demonstrate effective plutonium safeguards and thus regain for the United States international leadership and respect; four, nurture future beneficial uses of plutonium, such as recycle in breeder and conventional reactors; five, provide operational reliability and cost data for future commercial reprocessors; six, demonstrate recovery of strategic materials, such as the platinum family of rare metals, from the waste; seven, minimize the need for a special costly and wasteful spent fuel storage; and eight, provide input to DOE for cost adjustments to Waste Policy Act of 1982. I guess I should add a ninth, and that is to work out with NRC the required regulatory actions and requirements for a reprocessing facility.

We encourage the Government to move forward with a demonstration facility utilizing the Barnwell plant. Energy is a premium product, and only a complete and full nuclear power program will meet mankind's requirements for energy in the future. Thank you.

[The prepared statement of Mr. Boyer follows:]

Testimony Before the Subcommittee on Energy Research and Production
Committee on Science and Technology
U. S. House of Representatives
Washington, D. C.
March 2, 1983

by

Vincent S. Boyer
Sr. Vice President, Nuclear Power
Philadelphia Electric Company

I am pleased to submit testimony relating to the Fiscal Year 1984 Department of Energy Authorization request for the Nuclear Waste Management and Nuclear Fuel Cycle Research and Development programs. My remarks will relate to the reprocessing of spent fuel and to the desirability for utilizing the Barnwell Nuclear Fuel Plant in South Carolina.

The United States has long pioneered in the peaceful uses of nuclear energy. Our country has made great strides in developing the front end of the nuclear fuel cycle, but we have failed to complete the demonstration of the back end of the fuel cycle, namely, the reprocessing of commercially generated spent fuel. Reprocessing will enable the United States to maintain its leadership in the field of nuclear energy and enhance the promotion of nuclear safeguards around the world. While the Nuclear Waste Policy Act of 1982 provides for governmental acceptance of spent fuel by 1998, the timing of this action will not relieve utilities from the necessity of expending considerable sums for the construction of additional facilities to store the spent fuel generated to that date.

Philadelphia Electric Company operates two nuclear units at Peach Bottom, PA which are owned jointly with Public Service Electric and Gas, Delmarva, and Atlantic Electric Company. These two boiling water reactors, each with a capacity of 1055 megawatts, have achieved record performances while supplying low cost energy to our customers since 1974. We also own a portion of the Salem 1 and 2 pressurized water 1100 megawatt units operated by Public Service Electric and Gas Company of New Jersey. In addition, we are constructing the Limerick Generating Station with the two units, similar to Peach Bottom, to be placed in service in 1985 and 1988. In 1982, nuclear power accounted for 34% of the total output of Philadelphia Electric Company, enabling oil generation to be reduced to 7%.

Each of the Peach Bottom and Limerick reactors have cores that consist of 764 fuel bundles. To date, the spent fuel storage pools at Peach Bottom have about 2100 spent fuel bundles. Each of the Peach Bottom spent fuel pools have a maximum capacity of 2816 bundles. During 1985, both pools will lose full core discharge capability, and if additional steps are not taken, by 1990 the spent fuel pools will be completely filled.

By the end of 1983, the Peach Bottom fuel pools will contain over 400 metric tonnes of uranium with additional fuel being added at the rate of about 75 MTU per yr. To place the storage problem in perspective, the recently passed Nuclear Waste Policy Act of 1982 provides for away-from-reactor (AFR) storage capacity for only 1900 MTU for the entire country with the proposed AFR facility being many years from becoming a reality. One can readily see that the building of an AFR is not the answer to ours or other utilities' spent fuel storage problem. We must have reprocessing, and soon.

There are several reasons why reprocessing of spent fuel should be implemented at this time, and it is appropriate that a listing be presented.

1) Reduce need for supplemental spent fuel storage facilities on the part of utilities.

2) Enable the recovery and reuse of the residual uranium. Since it is partially enriched, an enrichment credit is also appropriate.

3) Considerably reduce the volume, hazard and cost of disposal of high-level nuclear waste material.

4) Provide the technical basis for needed follow-on reprocessing plants. It is estimated that three such plants will be required to fully accommodate the industry's needs.

5) Regain leadership in the world community so that we may influence international weapons proliferation controls.

The Barnwell Nuclear Fuel Plant in South Carolina was constructed as a commercial enterprise in the early 1970s with strong government encouragement. With changing administrations and because of concerns relating to the proliferation of nuclear weapons, the project was not permitted to be operated. By removing the reprocessing option, the United States hoped that other nations would follow its leadership. History has shown that our action was not followed by other nations, and that several are now proceeding with reprocessing.

With the passage of time, our country's leadership in the international nuclear community has diminished, and our original concepts are no longer valid. Furthermore, multi-nation study groups have concluded that the energy conservation and waste management benefits of reprocessing are far too important to forego. Moreover, an analysis of the methods for obtaining plutonium for military uses has clearly shown that a reprocessing plant is not a contributor of any significance to a nation's source of weapon grade plutonium.

Since 1978, congressional appropriations for R&D in support of national energy and non-proliferation objectives have maintained the Barnwell Plant and its technical staff. This R&D has been highly effective in the sense of both results and costs. In particular, the safeguards systems developed there during the past four yrs. provides a sound basis for easing international tensions by making possible widespread agreement on effective standardized safeguards for the reprocessing plants now being designed and built throughout the world.

With completion of demonstration of this advanced safeguards system in July, 1983, congressional funding for R&D at the Barnwell Plant is scheduled to cease. It would be tragic if alternative means cannot be developed to preserve this unique national asset--the Barnwell Plant and its staff--beyond that cutoff date. Closing the Barnwell Plant and dispensing its staff would have far-reaching adverse consequences. Nuclear power plants now in operation and under construction in the United States could require three plants, each the size of Barnwell, to keep up with their annual reprocessing needs. Unless the Barnwell Plant is placed in at least limited-scale demonstrational operation, it is virtually certain that these needed additional plants will not be built and that the benefits of energy conservation and improved waste management will be lost to the entire nation throughout the balance of the century and beyond.

The present administration is supportive of reprocessing as a private investment business. Industry also wants reprocessing to move forward but is skitish due to past governmental actions. Consequently, alternatives are being discussed, and it is hoped that Barnwell may be operated as a demonstration facility on a cooperative basis. Such actions would enable the Barnwell plant to:

1) Demonstrate safer, more economical nuclear waste disposal than the wasteful alternative of discarding spent fuel.

2) Provide definitive data for cost evaluations of fuel cycle options.

3) Demonstrate effective plutonium safeguards and thus regain for the United States international leadership and respect.

4) Nurture future beneficial uses of plutonium such as recycle in breeder and conventional reactors.

5) Provide operational reliability and cost data for future commercial reprocessors.

6) Demonstrate recovery of strategic materials, such as the platinum family of rare metals, from waste.

7) Minimize need for special costly and wasteful spent fuel storage.

8) Provide input to DOE for cost adjustments to Waste Policy Act of 1982.

The government should encourage such demonstration and the realization of these benefits which are clearly in the national interest. Energy is a premium product, and only a complete and full nuclear power program will meet mankind's requirements for energy in the future. I urge your committee to encourage and support this program.

Biographical Sketch

Vincent S. Boyer
Sr. Vice President - Nuclear Power
Philadelphia Electric Company

Vincent S. Boyer, Senior Vice President of Nuclear Power for Philadelphia Electric Company, received a Bachelor's degree in mechanical engineering from Swarthmore College. He received a Master's degree in mechanical engineering from the University of Pennsylvania where he also took graduate courses in nuclear reactor engineering and nuclear instrumentation. He received an honorary doctorate of engineering science from Spring Garden College in 1979.

Mr. Boyer joined Philadelphia Electric Company in 1939 as an engineer of plant tests in Electric Operations. He served as engineering officer of a destroyer from 1944 to 1946 in the U.S. Navy. He returned to Philadelphia Electric Company following his discharge and served in supervisory positions in power stations. He was appointed assistant superintendent of Cromby Station in 1953, and was named superintendent in 1956. He was designated superintendent of Peach Bottom Atomic Power Station in 1960 and was appointed manager of nuclear power in the Electric Operations Department in 1963. In January 1965, he was named general superintendent of Station Operating, and in July 1967, was appointed Manager of Electric Operations. In October 1968, he was appointed Vice President, Engineering & Research. In January 1980, he was elected to his present position of Senior Vice President, Nuclear Power.

Mr. Boyer is a Fellow of the American Nuclear Society and served as a Director and as President of the Society in 1976-77. He has also served as Chairman of the Reactor Operations Division. He is a Fellow of the American Society of Mechanical Engineers and past Chairman of the Philadelphia Section. Mr. Boyer has served as President of the Philadelphia Post of the Society of American Military Engineers. Mr. Boyer serves on the Board of Managers of Spring Garden College, as well as many industry committees. He is currently Chairman of EEI's Nuclear Power Executive Advisory Committee.

Mr. Boyer was selected by 50 scientific and technical societies in the Delaware Valley as Engineer of the Year for 1979 and was General Chairman of the 1980 Engineers' Week Committee.

In March 1980, Mr. Boyer was elected to membership in the National Academy of Engineering. The ASME honored Mr. Boyer in 1981 when he received the James N. Landis Medal. In 1982, The Engineers' Club of Philadelphia selected him as the George Washington Medalist for his Outstanding Service to the Engineering Profession.

July 1982

Mrs. Bouquard. Thank you very much, Mr. Boyer and Mr. Gray, for your testimony.

I agree with you that by removing the reprocessing option, we did not induce other nations to follow our leadership. We are certainly paying the price for losing our leadership at the present time. Instead, the Soviet Union has the most effective nonproliferation policy in the world, because they retain positive control over producing fuel. They ship them to the reactors, leasing them out, and then they bring them back into Russia for reprocessing. Would you all like to comment on this?

Mr. Boyer. Certainly the front end of the fuel cycle has been handled by private enterprise here, and under the American system we would like to get the whole cycle, at least as much as is reasonably practicable, under private enterprise. Furthermore, I think the concern you are referring to was to safeguards, and we believe that adequate safeguards can be employed throughout the whole fuel cycle, particularly at a reprocessing plant.

Another issue here in the basic concern with proliferation is that a reprocessing plant would encourage theft of material and encourage a nation which does not now have nuclear weapons capability to embark on such a program. A study group has looked at this and has concluded that there is very little probability of plutonium from nuclear fuel being used by a nation who wanted to embark on a nuclear weapons program. There are many other ways in which they can get much better material.

We feel that all the reasons, when they are examined, indicate that the way the United States is going is much better than the way that Russia is moving.

Mrs. Bouquard. You referred to the 400 metric tons of spent fuel at Peach Bottom. In 1965, there was a report issued by Batteile's Pacific Northwest Laboratory, entitled "The Value of Spent Fuels from Power Reactors." In this report they claim that a ton of spent fuel contains products valued at over $232,000. What is your estimate of today's value of spent fuel?

Mr. Boyer. It would be difficult for me to give you a number from the top of my head on the total value of the material in spent fuel, for that will occur by the time the respositories are available. I would say that reprocessing recovers approximately 35 percent of the uranium. It saves about 20 to 25 percent of the enrichment requirements for uranium to be used in the reactor, and it reduces the conversion cost by about 15 percent. If you take these contributing factors at today's cost for each segment here, you come up with a value that is roughly equivalent to the estimated cost of storing, which is somewhere around $155 or $175 per kilogram.

This does not take any credit for the value of plutonium, which with a viable breeder program would have considerable value.

Mrs. Bouquard. Basically, we all agree that industry needs some assurance that the political debate could not again swing in the other direction and jeopardize its investment in reprocessing. But at the same time, when there is this significant value in your spent fuel, what do you think that a utility might pay per ton for reprocessing if they could retain ownership to the resources?

Mr. Boyer. This is one of the things that a demonstration plant will help produce. The figures, which will give us good cost data on reprocessing, will give us good data on the recoverable material and enable us to make a true economic evaluation of the value of the reprocessing actions. It will also enable us to give better estimates and firm estimates on waste reduction and the effects there.

Mrs. **Bouquard**. Did we get some of this information at West Valley, Mr. Boyer?

Mr. **Boyer**. I cannot really answer that.

Mr. **Gray**. Could I comment? The question is, as you know, very broad. When you look at the totality of the composition of spent fuel and all of the elements there present, you have quite an array of materials. You then have the problem of extracting each of those and putting it in a condition that somebody will buy in the market. That in itself is a very complex scheme to work out. We did, I believe, at Hanford extract very large amounts of cesium 137, and I at one time was mixed up in a business that involved cobalt 60 applications which went very well.

It turned out that the arrangements were easier to make for the production of cobalt 60 in the Big Rock Point Reactor or the procurement of cobalt 60 from AECL in Canada, than it was to work out using that cesium 137. It was separated and it sat there, and I do not think there ever were any serious large applications developed for that cesium 137.

But dealing with bottom lines, I recall several years ago looking at some of these questions in working for the Edison Electric Institute. In a meeting that had to do with the value of spent fuel, there appeared the inevitable fellow who wanted to give it away. On that particular day and on that particular market, spent fuel had a negative value. He could not find anybody he could pay to take it off his hands. That is No. 1.

No. 2, I do not know what the value of plutonium is in today's market. There is no commercial market for plutonium today. There is none.

Mrs. **Bouquard**. In general, who owns the resources?

Mr. **Gray**. The utilities own them. Under the act of 1954, fissile materials go to the utilities. The uranium recovered is presumed to have value for reenrichment, and I think that is a fairly straightforward proposition. Then I believe there are two elements that in the reality of today's market you would look at in terms of the value of reprocessing at Barnwell. It is what do you save by adding spent fuel storage capacity, and what do you get back as a credit for the uranium that is recovered.

Both of those end up being sizeable numbers. You build on that. If, for instance, plutonium can be truly imputed to have a market value because it is going to be used by somebody in a breeder reactor system or for some other use, then you have a value to the plutonium. But you literally have to define markets for the products before you can really do much with the wonderful array of materials.

Mrs. **Bouquard**. In other words, you have to have somebody who will buy it before you can sell it.

Mr. **Gray**. Absolutely. And until the market is there, it is theory as to the totality of the values.

Mrs. **Bouquard**. I think I have gone over my 5 minutes.

Mr. **Boyer**. With regard to your West Valley comment, I might add that this was in a different licensing climate. The value of Barnwell as a demonstration plant would be on current licensing requirements and would also tie in with the waste program which was going on to enable firm data to be obtained as to the reduction or credits that can be looked for in the reduction in the waste volume. So as the cost of waste storage moved forward, the contribution of reprocessing and the reduction of the waste volume would be an important factor there, and that would be an important cost. In other words, we would expect through a reprocessing facility to obtain some credits from DOE on the 1 mil per kilowatt-hour that has been proposed.

Mrs. **Bouquard**. I have a followon question to Mr. Lujan's question. The 1 mil per kilowatt-hour is going to be industry's participation in our disposal program. We have established the fact that we are going to have a lower level of waste for disposal by virtue of reprocessing. Would not the 1 mil be in order for the reprocessing too? Would that be out of line?

Mr. **Boyer**. I think the two are not related. Whether it would come out to be 1 mil per kilowatt-hour or not would have to be calculated. It could be on that order of magnitude. But the 1 mil per kilowatt-hour is based on the waste storage program without reprocessing, which includes the storage of the large volume, the fuel elements, in that form. The reprocessing enables the waste to be solidified immediately, reduces the volume of waste that has to be handled because you are recovering the uranium and plutonium, and perhaps some other material.

Mrs. **Bouquard**. It reduces the volume?

Mr. **Gray**. It could be more or less, I think, in answer to your question.

Mr. **Boyer**. I really think we need to move forward and get more information so we can get definitive cost data. Right now, everything is based on envelopes and calculations and projections. But these, I think history has shown, do not always turn out to be as accurate as you would like them to be.

Mrs. **Bouquard**. Thank you. Mr. Ottinger?

Mr. **Ottinger**. Thank you, Madam Chairman.

I would like to start out with a request for you, Madam Chairman. The matters that were considered by these witnesses were testified to in beautiful harmony here but have tremendous consequences. I would like to request that we continue to pursue this line of inquiry by including some people who have very different views about the need for reprocessing and breeder technology and the prospect of proliferation.

We can resist proliferation by controlling it, which I know industry strongly believes can be accomplished as we turn around the policies of two previous administrations which restricted it. I think we ought to hear from some of the proliferation experts who have concerns. I think we ought to hear from the Union of Concerned Scientists on this question. So I would like to make that request at the outset.

I am not sufficiently qualified technically to be able to provide today the critical testimony myself, but I will express some concern and I would hope that we could have some experts with differing points of view before the subcommittee.

Mrs. BOUQUARD. We will be happy to discuss this with the gentleman.

Mr. OTTINGER. The testimony, from where I come, sounds as if we were in a dream world. It just seems counteractive of the realities as I understand them. The world is awash in uranium. The price of uranium is exceedingly low. There is so much excess uranium that Mr. Domenici is pounding on us to try and create import controls in the United States at the present time so that we can maintain our existing uranium industry. The need for building reprocessing breeders at this point is just nil.

With proliferation dangers pendent on going to a plutonium cycle, we ought not to embark on any industrial-size program for reprocessing at this time.

Mr. GRAY. No. Research and development program.

Mr. OTTINGER. You talked about industrial size——

Mr. GRAY. I believe my testimony was that a commercial scale full reprocessing is not warranted.

Mr. OTTINGER. I would hope that we could resume the research. I have no ideological bias about pursuing the option or getting the energy that is available from existing spent fuel. But I do think that it is a terribly frightening prospect today to have highly enriched unranium and plutonium to start to circulate around the world from which nuclear bombs can readily be made.

Mr. Boyer, you repeated the same kind of assurance that Mr. McCormack gave us many times, that whenever a country wanted to create bombs, the fuel cycle would be the last place in the world that he would look for it. The fact of the matter is that the one country that did decide to produce nuclear explosives did so by diverting materials from its civilian reactor.

Mrs. BOUQUARD. Incidentally, that was not a commercial reactor.

Mr. OTTINGER. It was a research reactor. I believe the gentlelady is correct.

Your testimony as I heard it sounded like a very strong advocacy of bailing out Barnwell. But the gift does not seem to be a very attractive gift if whatever amounts might be invested by tbe industry were transferred to the U.S. Government in pursuing its options. I have here with me an article which I just recently read that the British are slowing down their program, while the French have decided not to pursue a breeder beyond the existing Phoenix II reactor. The whole world conditions are militating against pursuing this. It is only the industry that wants to sail ahead.

I am very concerned because of the dangers that are attendant today in doing this when it appears to be both unnecessary and uneconomic. Your turn at bat.

Mr. GRAY. Thank you. I would like to first concur with the thought you are expressing at the outset as it related to uranium and then say to you something that you are very aware of.

The world is awash in a glut of all forms of energy. There is more coal, there is more oil, there is more gas, there is more uranium, there is more solar. There is more of everything right now. The demand for energy is down right across the board, domestically and internationally. I accept that in a narrow sense, this means that one can pause and look at things. I also believe that the invitation to testify here today has to do with long-range policy, and I also believe firmly that long-range policy for the United States and for the global community of which we are a part demands a lot more work on solar than is going on right now, and a lot more work on synfuels than is going on right now. It is a good time to put ourselves in better shape for the future, as far as energy generally is concerned.

I know and you know that the specific demand for somebody to buy a breeder is kind of out there in the future somewhere, a breeder for commercial use. However, I will take as much time as you give me, in days, to argue the case in favor of the breeder as being one of the finest concepts for energy production that the world has ever seen. It is a concept which is being developed and will be developed in time. When it will be used commercially, I do not have the foggiest notion.

I think it would be unwise to abandon it as an energy concept for development by this country. And that has nothing to do with Barnwell. Bailing out Barnwell is not a particular interest of mine. It happens to be a facility that is in place and which has high values for programs that, in my opinion, have very long-term value. I am not in any instance an advocate of premature commercialization of anything: breeders, thermal recycle, and all those things. Forget it. Premature commercialization is a mistake on anybody's part on any energy technology or any other technology.

I really believe that if you take a long-term view on this, without regard to Barnwell—and testifying on the Nuclear Nonproliferation Act before the Senate folks involved at the time, I recall saying, "Your view is too narrow. Until we have a nonproliferation regime which embraces the ability to do breeder reactors, we haven't solved the problem." I say that very deadly seriously. You do not solve the problem by saying, "plutonium, go away" or "Breeder, go away." Plutonium is not going to go away, and the breeder is not going to go away.

Let us develop a nonproliferation regime in which it is possible to carry forward the proper energy supply interests of the nations that we work with on these things. I say that with a reasonably sophisticated knowledge of the nonproliferation regime. I, in some places, am mistaken as an authority on nonproliferation matters. I have dread fear of atomic weapons in anybody's hands. It is a little bit too much to put in the hands of mankind. At the same time, I say that until we have a nonproliferation regime which embraces the possibility of breeders, then we have not done our job.

My testimony is presented in that context.

Mr. OTTINGER. I think if the international community cannot organize itself in such a way as to restrict the use of plutonium, and if it appears that breeder reactors are an economic way to go, then nonproliferation interests would indicate that if we can work it out with the international community it would be by far best to have all the spent fuel returned to us and we could then do all the reprocessing of it. I think those questions really ought to be examined very carefully before we sail off promoting these technologies, promoting the sale of reprocessing, as this administration has said, by considering promoting the sale of enrichment equipment in other countries, allowing proliferation just to take place with our encouragement.

I think we were achieving some real progress with the French and the Germans by getting restrictions prior to this administration coming into office, and that is seriously jeopardized by the present administration which actually subverts the Nonproliferation Act. It would supply materials which would not be permitted under the act to India, and it contemplates a very strong promotion——

We ought to proceed with the greatest caution because the dangers are far greater than the Russians. I think the likelihood that Russia and the United States would drop bombs on each other is very small because each has the capability. But there is no effective protection against terrorist groups or irresponsible countries gaining that technology. The only recourse that you have is the Israeli recourse: Go take it out militarily before it develops. That is hardly a satisfactory way to organize peace in the world and security.

I would just like to advocate that this committee go into the alternative ways of proceeding on this with the utmost care. We need your assistance and guidance. I do not say I have all the answers, but I say we had better be very, very careful, because the path on which we are embarked now seems to me to be extraordinarily dangerous.

Mr. **Boyer**. I might just comment that of course the United States is in a very enviable position with regard to energy. We are better off than any other country in the world, and the world is going to make improvements in the energy situation as time goes on, in the long range in the developing nations. I would submit that putting ourselves in a cocoon is not going to put us in a position to influence the way in which that progress moves, and that the best way for us to see that things are done in a manner we want them to be is to be a participant. This is another reason why we should move forward with the reprocessing and the breeder and inject ourselves in the international arena, where we have stature in these areas and can make controls.

Mr. **Ottinger**. I have heard that said many times by representatives of the industry, but they never spell out how they are going to make that control. The IAEA says at the present time they do not have the capability to give timely warning when plutonium or highly enriched uranium is involved. No scheme has been worked out. It is relatively simple and quick to convert plutonium, once you get it, into an explosive device. As a concept, it sounds kind of good that we have to be an actor in order to have control. What we are actually doing is being a promoter.

I think it is to promote the commercial interest of the industry, which hopes to be able to sell this material and does not want to see it go to other countries. I can understand that, but I think there just has to be some kind of international agreements so that today there are effective constraints and you will not see a world where terrorist organizations will blackmail the world with nuclear explosives.

I have heard the theory advanced but I have never had it explained to me how you get effective controls from promoting reprocessing and breeder reactors on our own.

Mr. **Gray**. May I comment? I have been a party to a lot of nonproliferation discussions, and I do not know of any industry people who are proproliferation. I simply do not. I will say factually that a very large number of people in the utility industry do not have the sense of what the nuclear weapons matter is all about, which is enjoyed by some of the folks in Congress.

I have objected to the thought that industry is somehow indifferent to proliferation. I really do not believe that, and I do not think you believe that either. I think that there are means, although it is way beyond the scope of this hearing, of combining in institutions, governmental or private, the economic interest and the nonproliferation interest that you are so vitally concerned about.

I spent a couple of weekends ago in the United Kingdon on proliferation, and we talked into the business of what I was told not to call "cartels" but to call "consortia" that would deal with enrichment or with plutonium supply and control. If you do get to the point of developing these matters further, I would hope that you would get into "institutional fixes." The institutional approach to some of these things is vital to combining the interests that too often are presented as adversary interests in our own system. One of our problems is that there are adversarial interests that have to be combined. It is not easy to do but they have to be combined. You need institutions that are concerned with supply and with nonproliferation.

There are such. URENCO is one of them. I use that as an example of an institution that has a supply and a nonproliferation mandate from governmental levels in the countries that own it.

Mr. **Ottinger**. I think the matter is of grave importance and ought to be pursued carefully. The decision to proceed with Barnwell could hurt the scenario in the long term of how we are going to be able to manage the proliferation problem in the future; I would hope that we would do that carefully and thoroughly.

Mr. **Boyer**. And I am submitting that Barnwell has, in a very broad context, specific applications to control proliferation internationally. It goes beyond the conduct of safeguard programs at Barnwell. I think you are suggesting something that is very important, and that to date has not been fully developed: What would you do with a Barnwell as it relates to the international envelope. There are answers to that question.

Mrs. **Bouquard**. Thank you very much.

If the gentleman would yield, our funding for Barnwell terminates in July, so this is an issue that we will be looking into further, and we certainly hope to have the benefit of your thinking in the later days as we pursue this concept.

Mr. **Ottinger**. I have one more question our staff has suggested, which I think is interesting. What R&D work in pyrochemical and laser photochemistry can be done to further advance the state of reprocessing for future operations at Barnwell? How can the separation process be improved to further reduce the volume of high-level waste for disposal? If we do Barnwell, we want to do it well.

Mr. **Boyer**. Certainly these are areas which could be looked into in a demonstration facility. It is much better to do them in that type of facility than it is in a small laboratory, where the results do not always scale up to give the same overall results as you first contemplate that they will.

Mrs. **Bouquard**. Thank you, Mr. Ottinger.

I would like to ask all of our witnesses if they would answer further questions for the record. They will be submitted to you.

This subcommittee will have its next hearing on Wednesday, March 9, at 9:30 in this room. The hearing will be on the conventional reactor systems, AGCR, LWR's and so forth, and we will hear from DOE and non-DOE witnesses.

Again, I would thank all of you who participated. The subcommittee is adjourned.

[Whereupon, at 12 noon, the subcommittee recessed, to reconvene on Wednesday, March 9, 1983, at 9:30 a.m.]

APPENDIX

Rockwell Hanford Operations
Energy Systems Group
P.O. Box 800
Richland, WA 99352

March 28, 1983

In reply, refer to letter #R83-1189

Honorable Marilyn Lloyd Bouquard
Subcommittee on Energy Research
and Production
Suite 2321, Rayburn House Office Building
Washington, D.C. 20515

Dear Congresswoman Bouquard:

SUPPLEMENT TO TESTIMONY PROVIDED MARCH 2, 1983

Thank you for your letter requesting additional information to supplement my March 2 testimony before your subcommittee. Attachment 1 provides brief answers to each of the three questions.

Thank you again for the opportunity to appear before the subcommittee. If I may be of further assistance, please contact me.

Very truly yours,

R. A. Deju, Director
Basalt Waste Isolation Project

RAD/DJF/jac

Att.

Attachment 1

SUPPLEMENT TO MARCH 2, 1983, TESTIMONY
PROVIDED BY DR. R. A. DEJU

1. *Would you please state your views on whether a utility group should be set up for the purpose of providing comments to Congress on DOE's Waste Fund activities?*

1. In our role as contractor to the U.S. Department of Energy (DOE), Rockwell Hanford Operations' Basalt Waste Isolation Project is responsible for assessing the feasibility of storing high-level radioactive waste deep in the basalt flows beneath the Hanford Site. In this endeavor, we are not involved in the overview of DOE's Waste Fund. It seems more appropriate that the utility groups be asked to comment on the level of overview they see necessary to oversee DOE's Waste Fund activities.

2. *Do you believe that funding for DOE's Mission Plan should be set aside by Congress, and if so, how much funding should be allocated?*

2. After review of the Nuclear Waste Policy Act of 1982, and specifically the requirements for the Mission Plan, I believe it is an important document regarding the management of the program. As such I believe it would be appropriate that funding be provided to the DOE by Congress to accomplish this action. I have not been involved in the planning for this activity and cannot comment on the funding level required.

3. *What is the status of the 6-foot diameter exploratory shaft and other siting research at the Hanford Site? Please provide your timetable for beginning and concluding the siting research, or "site characterization" process.*

3. The DOE has placed the exploratory shaft on a secured stand-by status and the decision to proceed with drilling of the exploratory shaft will be made by the DOE. Other siting research including studies of geology and hydrology, waste package studies, conceptual design work, work on performance assessment, and computer modeling are continuing. Our studies are aimed at providing the necessary input for the President's recommendation of a site in 1987.

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Congress of the United States
OFFICE OF TECHNOLOGY ASSESSMENT
WASHINGTON, D.C. 20510

JOHN H. GIBBONS
DIRECTOR

April 18, 1983

The Honorable Marilyn Lloyd Bouquard
Chairman
Subcommittee on Energy Research and Production
Committee on Science and Technology
U.S. House of Representatives
Washington, D.C. 20515

Dear Marilyn:

Thank you again for the opportunity for the Office of Technology Assessment to present testimony to your Subcommittee on March 2. I am enclosing our response to the supplemental questions which you sent us on March 16.

Please let us know if we can be of any further assistance to you.

Sincerely,

Jack

John H. Gibbons

Enclosure

RESPONSE TO QUESTIONS FROM THE HOUSE COMMITTEE ON SCIENCE AND TECHNOLOGY

To the Office of Technology Assessment

1. Do you believe that the DOE should attempt to minimize utility systems cost by developing a single canister suitable for spent fuel storage, transportation, and disposal?

The concept of using a single container for spent fuel storage, transportation, and eventual disposal is intuitively very attractive as a way of reducing the costs of high-level radioactive waste management. However, our analysis indicates that it is not possible at this time to conclude with certainty that overall system costs would in fact be minimized by such an approach, since there are a number of factors (discussed below) that could offset some of the more obvious cost savings. A careful systems analysis taking all of these factors into account would be needed to determine the anticipated net effect on total systems costs. While we cannot predict what an analysis of the possible advantages and disadvantages of use of a single container for storage, transportation, and disposal would show, it appears important for DOE to conduct such an analysis in order to resolve the question before many utilities have to make final decisions about interim spent fuel storage facilities. If DOE wishes to adopt any standardized design for a multi-purpose container, it would be useful to do so before there is a proliferation of idiosyncratic, utility-specific designs optimized for each utility's individual needs rather than for overall system costs and performance.

The following discussion identifies some of the considerations that must be addressed in a systems analysis of the optimum container design. This discussion will distinguish between two distinct types of containers to which this question could apply: casks, and canisters. The term cask generally refers to a relatively large container intended for storage and/or transportation of spent fuel or solidified high-level waste. Such casks are generally quite massive because they are designed to provide both radiation shielding and physical protection to prevent radioactive releases even in the event of accidental physical impacts or even of deliberate sabotage using high explosives. The term canister usually refers to a much smaller and lighter device, perhaps as simple as a carbon steel cylinder, used for encapsulating one or several spent fuel assemblies for subsequent emplacement in some sort of storage facility (e.g. a cask or a drywell) and later into a more sophisticated disposal package (e.g. a titanium canister). Such a canister would be designed for convenient handling and perhaps to prevent the release of radioactive gases or surface deposits from the spent fuel, but not for radiation shielding or major physical protection.

A number of large casks are already in use for spent fuel transportation, and casks are also under development for use for interim spent fuel storage. In addition, the possibility of direct disposal of spent fuel in the cask used to transport the spent fuel to the repository has been suggested. Development of a single cask that could be used for storage, transportation, and disposal of spent fuel has several potential benefits. First, it would substantially simplify the process of spent fuel management from the time the fuel is removed from the reactor to the time it is emplaced in a repository (if the spent fuel is to be disposed of directly without reprocessing). This would reduce the operational risks and worker exposure involved in waste management, since it would limit the number of times that any spent fuel element would be handled directly to the one step of removal from the reactor storage basin and emplacement in the cask for storage.

Second, it could reduce the overall costs of waste management. For example, if a storage cask can also be used for transporation, then transportation costs could be reduced by eliminating the need for lease or purchase of a separate transportation cask, and the cost of transferring the spent fuel from the storage cask to the transportation cask. Of course, this savings could be partially or totally offset if a dual-purpose cask cost substantially more than a single-purpose one.

A single cask suitable for storage as well as transportation could reduce transportation costs compared to current transportation casks, which are designed to allow transportation of very hot spent fuel that is only about 6 months old. In contrast, the storage casks now under consideration are designed to accept only spent fuel that is at least 5 years old. This allows more spent fuel to be placed into a cask, which reduces cost, number of separate shipments, and public radiation exposure per ton-mile of transportation. In addition, it may render moot some of the debate about the safety of high-level waste transportation, since the strongest criticisms of transportation safety are based on accident scenarios involving very hot, 150 day old spent fuel.[1] If the waste transportation system is designed so that only spent fuel that is older than 5 years can be transported, the maximum potential consequences from a transportation accident, or from deliberate sabotage, would be greatly reduced.

While in principle it appears possible that use of the storage/transportation cask for final disposal as well would also reduce the total costs further, there are a number of factors which might offset such reductions. For example, the repository standards and regulations currently being developed by the NRC may include specific numerical performance criteria for the life of the waste package. This could impose design requirements on the disposal container that are more stringent than those for storage and transportation, which could in turn increase the costs of the storage/transportation cask if it were to be used for disposal as well. (In any case, it may not be easy to ensure that the cask would meet the disposal standards after it had been used for storage in the open air for a period of decades and then subjected to the stress of transportation fully-loaded for a distance of perhaps thousands of miles.) Furthermore, a storage/transportation cask might be reusable after it had delivered a load of spent fuel to a repository, and the potential cost savings from such reuse would have to be balanced against any savings from direct disposal of the spent fuel in that cask.

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[1] Resnikoff, Marvin. The Next Nuclear Gamble: Transportation and Storage of Nuclear Waste. New York: Council on Economic Priorities, 1983, p. 268.

Another consideration is the fact that a fully-loaded storage/transportation cask of the sort now under consideration for at-reactor storage would weigh on the order of 100 tons. About 10 tons of this represents spent fuel; the rest is the cask itself, which includes a large amount of radiation shielding and mechanical shielding for integrity in case of handling or transportation accidents. Current DOE reference repository designs assume use of disposal canisters containing at most about one metric ton of fuel, with little radiation shielding and without the physical shielding required of a transportation/storage cask. Use of a much heavier cask for disposal would require more expensive equipment for lowering the waste containers into the repository and emplacing them, and may substantially lower the achievable repository loading rate. (For example, if the loading elevator can handle a maximum of 100 tons, it could lower either one transportation cask containing 10 MTU of spent fuel, or perhaps as many as 50 smaller canisters each containing about 1 MTU.)

On the other hand, direct disposal of spent fuel in the storage/transportation casks would eliminate the need for extensive packaging facilities at the repository, and for drilling holes in the floor of repository rooms to hold the waste containers. In addition, the greater radiation shielding provided by the cask could perhaps eliminate the need for remote handling during emplacement in the repository. As noted above, a careful systems analysis that balances all of these factors would be needed to determine the least-cost approach.

Even if it does not prove to be cost effective to develop a single cask for storage, transportation, and disposal, there may be advantages to designing a spent fuel canister that could be used for all three purposes. Since encapsulation of spent fuel elements in a simple canister may be required at one or more stages of the waste management process (e.g. in case rod consolidation is used for storage), it may be useful to develop a single standardized canister design that would be compatible with storage, transportation, and disposal systems, so that spent fuel would not have to be re-encapsulated at any stage. For this purpose, the standardization required may be as simple as the adoption of standard dimensions for the canister. The analysis needed to justify such standardization should be somewhat less complex than that required to justify a single cask for storage, transportation, and disposal.

2. Is it your assessment that the DOE has concentrated on independently developing canisters for each use or mode, that is, separately for spent fuel storage, transportation, and disposal?

It is our understanding that to date, the principal focus of DOE's efforts with regard to casks, as opposed to canisters, has been on casks suitable for spent fuel storage. There are two types of casks now under consideration for storage: expanded versions of current commercial transportation cask designs (CASTOR, Transnuclear), and entirely new designs developed specifically for storage (Ridihalgh, Eggers and Associates [REA]). The CASTOR and Transnuclear storage casks are specifically designed to be used for transportation as well, and the smaller versions have already been licensed for that purpose. The REA storage cask would require a special overpack to allow transportation, although this is not expected to add greatly to the cost. The DOE is currently cooperating with the Tennessee Valley Authority in a licensed demonstration of the CASTOR and REA casks for spent fuel storage at TVA's Browns Ferry reactors. None of these designs have been developed with an eye to their use for final disposal.

Discussions with DOE staff show an interest on their part in exploring the possible use of such casks for both transportation and disposal. Presumably, the provision in the Nuclear Waste Policy Act for the DOE to take title to spent fuel at reactors and transport it to interim storage or disposal would require the Department to take a leadership role in the design of the transportation system. In this case, one would expect the Department to have an R&D program directed specifically at the question of the optimum transportation cask design, and that program should be closely coordinated, or integrated, with the program for developing storage casks (e.g. the dry storage R&D program authorized by Sec.218[c]) and with the program for developing packages for spent fuel disposal that must be included in the mission plan (Sec.301[a][8]).

Even if such an R&D program concludes that it is not advisable to use the same cask for disposal as for storage and transportation, it should determine whether some standardization would be useful for the spent fuel canisters that may be required with some interim storage technologies, to ensure compatibility with the design for the final disposal package. This would require coordination between the dry storage R&D program and the disposal package development program.

Because of the value of timely resolution of the question of whether a single standard cask or canister is to be used for storage, transportation, and disposal, it could be useful for the mission plan to include an an integrated R&D plan to provide the information needed to answer the question. The time schedule for this R&D program should be based on an analysis of when a decision for standardization must be made so that subsequent decisions (e.g. about interim storage facilities or repository design) can take that decision into account.

3. On page 9 of your testimony, you recommend a "pilot stage" operation of the repository. Isn't this essentially a TEF as authorized by this committee? Please explain any difference between your concept and the TEF concept.

The principal difference between the pilot phase of repository operation as described in OTA's testimony and the Test and Evaluation Facility (TEF) is the fact that the pilot phase takes place after, rather than before, the NRC issues a construction authorization for the repository site. (Thus by definition the pilot phase must be at a repository site, while the Nuclear Waste Policy Act allows a TEF to be either colocated with a repository or at a separate site.) NRC approval of emplacement of a small amount of waste or spent fuel into the repository following construction authorization but before issuance of an operating permit for full-scale operation would be analogous to approval of low-power operation of a reactor. Thus all of the activities in the pilot phase would occur under licensed conditions. In contrast, section 217(f)(2) specifies that the TEF would be an R&D facility that would not be subject to NRC licensing.

As we noted in our testimony, a licensed pilot phase would be consistent with a colocated TEF facility. However, whatever the decision about colocation of a TEF with the repository, inclusion of an early pilot phase of repository operation following the construction authorization would offer a number of potential benefits:

1. It would allow an early test of one of the crucial steps in the licensing process: NRC's ability to decide to allow actual "disposal" - permanent emplacement of waste in a repository with no foreseeable intent of recovery (Sec.2[9]). What is needed to "demonstrate" that radioactive waste

can and will be safely disposed of is not only the physical technology of disposal (which could be accomplished through an unlicensed TEF), but also the institutional capacity of the NRC to make a regulatory decision that a repository at a specific site can be expected to provide the required degree of waste isolation. Thus a licensed pilot phase of operation could provide an early complete demonstration of both the physical and the institutional requirements for disposal. High level waste or spent fuel placed into a TEF would not represent "disposal" as defined in the Act until NRC granted formal approval of permanent emplacement, which under DOE reference repository development plans would not occur until the full-scale surface packaging and handling facilities of the repository had been built, some 6-8 years after the construction authorization.

2. Because the pilot phase would represent true disposal as defined in the Act, it should satisfy the requirement in section 302(a)(5) that disposal in a repository begin by January 31, 1998. The Act does not specify the level of operation that must begin by that time, but it does specify that the emplacement be "disposal," which presupposes NRC permission for permanent emplacement with no intent of recovery. Thus, if the approach to repository development chosen by DOE includes a pilot phase, actual initiation of disposal could begin perhaps several years earlier than 1998 (assuming that the construction authorization for the first repository is granted on schedule), since permanent emplacement of some waste could occur before completion of the full-scale packaging facilities.

If initial licensed operation of the repository is planned to take place during a pilot phase, it is possible that the 1998 deadline could still be met even if there are delays in issuance of a construction authorization for a first site. In fact, it is possible that the deadline could be met by using a pilot phase approach even if it became necessary to use one of the sites from the second round of site characterization for the first repository; if one of those sites is approved by NRC by the 1995 deadline for action on the second license application, there would be 3 years to initiate operations before the 1998 target. While this could probably be done in time with a pilot phase approach, it could not be done that quickly if initial operation has to await construction of the full-scale surface facilities.

3. Because the pilot phase would be licensed, it could allow emplacement of more than the 100 MTU to which the TEF is limited. For example, if an integrated test facility for R&D on handling, packaging, and emplacement technologies and techniques for both storage and disposal were developed, all of the waste packaged during those tests could be emplaced in the repository during the pilot phase. As suggested in our testimony, this could amount to 300 MTU or more.

A licensed pilot phase could of course be integrated with a colocated TEF facility if it is judged to be useful to emplace up to 100 MTU of waste or spent fuel into the repository before the construction authorization. The decision whether to construct a colocated TEF should take into account the possibility that use of a pilot phase by itself may allow much of the data and experience that would be provided by a colocated TEF to be obtained within a few years of the time such a TEF could begin operation, with less procedural complication. (Since the pilot phase would be an integral step in the development of the licensed repository, it would be covered by the procedural requirements for the repository, and should not involve all of the additional procedural steps required for a colocated TEF.)

A pilot phase of repository operation could also be used to complement a non-colocated TEF in an integrated R&D program. The non-colocated TEF could be constructed substantially earlier than a colocated one, without the same procedural complications, and thus could provide much useful generic data and experience in time to be useful in the design of the repository and the construction authorization process. At the same time, the site-specific information that could be gained from a colocated TEF could be obtained during the pilot phase of operation following the construction authorization. While this information would not be available until several years later than would be the case with a colocated TEF, it could still be in time to contribute to the final refinement of the repository design and to the application for authorization for full-scale repository operation.

Clearly, our discussion of the possible relationship between a licensed pilot phase of repository operation and a TEF is only suggestive, since a definitive answer would require an extensive analysis of the time schedule on which the information to be provided by such facilities would be needed. Since sec.301(a)(2) appears to require that the mission plan contain such an analysis, it could be useful for DOE to present in the first draft of the mission plan a comparison of several approaches for providing the needed information, including the approaches discussed above.

1984 DEPARTMENT OF ENERGY AUTHORIZATION

TUESDAY, MARCH 8, 1983

House of Representatives,
Committee on Science and Technology,
Subcommittee on Energy Research and Production,
Washington, D.C.

The subcommittee met, pursuant to notice, at 1:59 p.m., in room 2318, Rayburn House Office Building, Hon. Marilyn Bouquard (chairman of the subcommittee) presiding.

Present: Representatives Bouquard and Valentine.

Staff present: Nelson L. Milder, technical consultant; David Clement, minority counsel; and William Harvey, minority energy coordinator.

Mrs. Bouquard. The subcommittee will come to order. Good afternoon, ladies and gentlemen. Today we will be receiving testimony from the Department of Energy on the Department of Energy's fiscal year 1984 budget request for the advanced nuclear systems program. This is the program that is responsible for developing the nuclear power sources and systems for the U.S. military and civilian space and terrestrial missions.

This is the first time that the subcommittee has held a separate hearing on the subject. There are at least two reasons why I believe such special attention is justified at this time. To begin with, this Nation is entering a new era in the development of space and nuclear power technology. The success of the radioisotope thermoelectric generator, or RTG, on 22 prior space missions has assured the availability of reliable, safe, low-power and long-life electric energy sources for a host of spacecraft requirements. Work is now proceeding to the next phase—production of nuclear reactors that will provide many kilowatts, and even megawatts, of electricity for the more demanding space missions of the future. It is essential that this subcommittee understand the extent and significance of the progress that has been made to date, and be fully aware of the direction, from both a technical and a policy standpoint, that this work is taking.

Next, we need to examine the recently signed Memorandum of Agreement, in which DOE, NASA, and DARPA have agreed to pool resources—technical, management and dollars—to explore the space nuclear reaction power option in sufficient detail to permit a decision on its future practicality by 1986. Should this conceptual design phase prove successful, the next level of effort—building a ground engineering system—would require a major funding commitment from all parties involved, including this subcommittee.

It is important that, as the missions for space nuclear reactors are identified, the needs of both the civilian and military sectors are provided for. As the subcommittee is responsible for the civilian energy technology developments, we will be especially concerned that the important initial phases of the cooperative arrangement between these two interests do not lose sight of the civilian—or NASA—requirements.

As a member of the Armed Services Committee, however, I must also state that I will be most interested in assuring that our space nuclear power technology does not lag that of our colleagues in the Soviet Union.

I, therefore, welcome our distinguished witnesses to this "first-of-a-kind" review.

We will begin with a program overview by Mr. Gordon Chipman, who, among his other important duties as a Deputy Assistant Secretary in DOE, serves as Acting Director of the Office of Space Reactor programs. He will be followed by, and participate in, a panel consisting of Dr. Jack Kerrebrock, Associate Administrator of NASA's Office of Aeronautics and Space Technology, and Dr. Robert S. Cooper, Director of the Defense Advanced Research Projects Agency.

We will close with testimony from the two principal laboratories presently involved in the technical development of space nuclear reactor systems. Dr. Rea of the Jet Propulsion Laboratory and Mr. Hanson of the Los Alamos National Laboratory will discuss the roles of their respective institutions in this program.

Before we begin receiving testimony I believe there is a vote, so we will have a short recess and I do apologize for the delay.

[Recess.]

Mrs. Bouquard. With Mr. Chipman, we have Mr. Steve Lanes who is a former member of this committee. We welcome you back, Steve, and also Mr. Bernie Rock. Please proceed with your testimony.

STATEMENT OF GORDON L. CHIPMAN, JR., DEPUTY ASSISTANT SECRETARY FOR BREEDER REACTOR PROGRAMS, DEPARTMENT OF ENERGY

Mr. Chipman. Thank you, Madam Chairman. It is certainly a pleasure to appear before you again and discuss such an important topic at this time. I've been looking forward to it. I'm glad to have my comrades here. Mr. Rock is in charge of the special nuclear project that mostly focuses on the RTG effort. He has been in that program for some time. As you know, Steve Lanes is my Deputy.

Mrs. Bouquard. It looks like you are in good company and you have very good command of the situation this afternoon, Gordon, and I look forward to hearing from you.

Mr. Chipman. Thank you.

I'd like to summarize my testimony, Madam Chairman, if I could. As you know, when Dr. Brewer was here, attached to his formal testimony was a rather lengthy presentation regarding the space nuclear program. In addition, I have a rather brief formal statement that is submitted for the record today.

Mrs. Bouquard. Your statement will be made a part of the record—your complete statement. You may summarize as you wish.

Mr. Chipman. Thank you, Madam Chairman.

SPACE NUCLEAR
PROJECTS PROGRAM

DEPARTMENT OF ENERGY

I would like to start by briefly reviewing the history of space nuclear programs. It's clear, I think most of us know, since the early 1950s we've been working in the area of space nuclear power.

I will be using some slides for illustration as I go along in my summation.

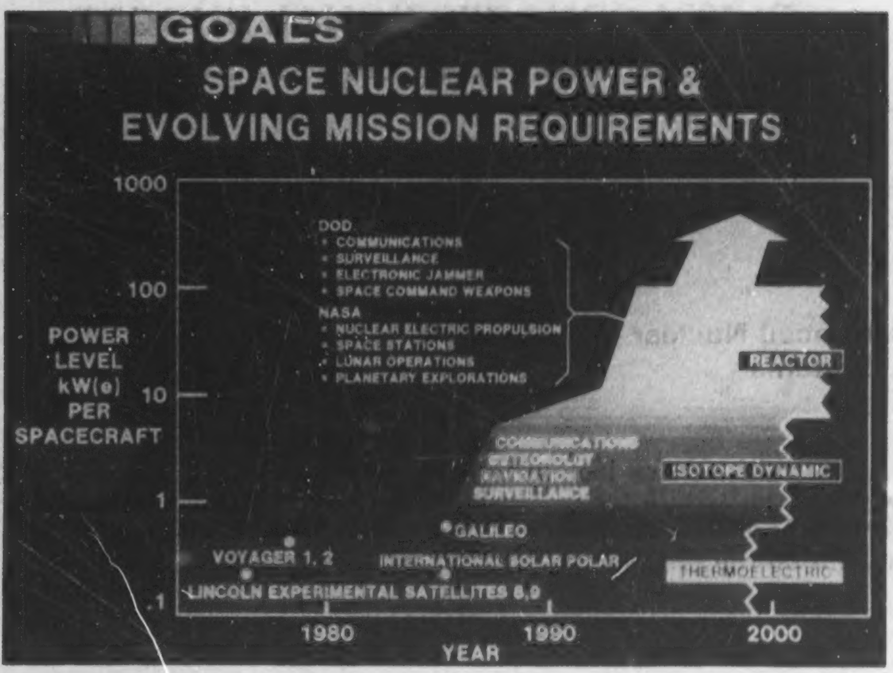
BACKGROUND

- **US active on studies and development of Space Nuclear Power and Propulsion since 1951**
- **38 Nuclear Power Systems successfully flown on 23 DOD and NASA missions**
- **All but one system were RTGs, Radioisotope Thermoelectric Generator**
- **Unlike USSR, the US has only flown one reactor in space, the 500-watt SNAP-10A in 1965**
- **Many other, higher-powered systems under development by DOE were terminated short of flight tests, because of budgetary pressures and/or changes in user interest**

Slide 1

As shown on slide 1, the main efforts in this regard have been to service both NASA and DOD needs for various missions. As you can see from this slide, we have some 38 nuclear systems that have been successfully launched in about 23 missions. That's quite a large number more than most people are familiar with. All of these, of course, were RTG's or radioisotope thermoelectric generators, except the SNAP-10A, which was a reactor. The Russians have been flying reactors for many years now. Since we flew the SNAP-10A in 1965, we have had no further space flights of reactors. But that program, as we'll be getting into in a moment, has been revived. The current program is divided into three basic elements; we have the RTG work, which services the near-term missions of NASA; we have the space reactor work, which I'll be discussing; and of course, there are the special applications, which you are probably familiar with.

The systems that are used for space nuclear power cover a wide range of power uses, and we are developing the more advanced ones at this time. As you can see from slide 2, we see in the future a need to develop higher power level capability for a wide variety of missions. Some of these missions are indicated there for both DOD and NASA.



GOALS

SPACE NUCLEAR POWER &
EVOLVING MISSION REQUIREMENTS

DOD
- COMMUNICATIONS
- SURVEILLANCE
- ELECTRONIC JAMMER
- SPACE COMMAND WEAPONS

NASA
- NUCLEAR ELECTRIC PROPULSION
- SPACE STATIONS
- LUNAR OPERATIONS
- PLANETARY EXPLORATIONS

Slide 2

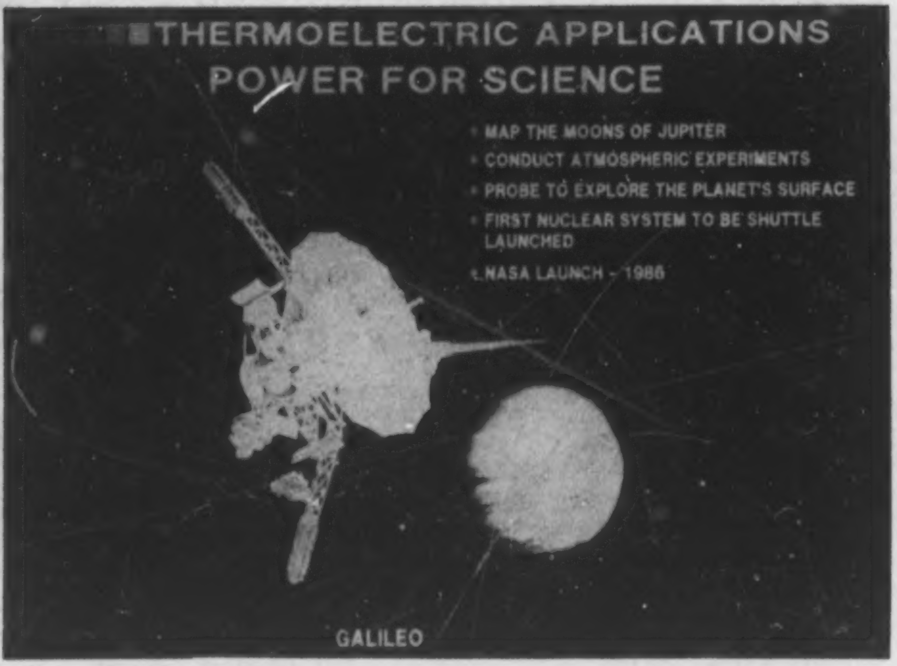
We are moving from the RTG power sources, which provide relatively low-power cabability, to an intermediate power capability in the dynamic isotope power systems. These are basically isotope power units that have some kind of a turbine or other active power conversion system attached. The ultimate goal, of course, is being able to provide rather large amounts of electric power from the reactors themselves.

FY 1984 CONGRESSIONAL BUDGET ADVANCED NUCLEAR SYSTEMS

	FY 1982 Appropriation	FY 1983 Recommended Continuing Resolution	FY 1984 Request
Advanced Nuclear Systems	37.6	38.9	34.1

Slide 3

If we take a quick look at the budget, situation, shown on slide 3, we find that while there has been some concern about the budget for the last year or two, and the upcoming year, there is no constraint on the program itself as a result of the 1984 budget.



THERMOELECTRIC APPLICATIONS
POWER FOR SCIENCE

- MAP THE MOONS OF JUPITER
- CONDUCT ATMOSPHERIC EXPERIMENTS
- PROBE TO EXPLORE THE PLANET'S SURFACE
- FIRST NUCLEAR SYSTEM TO BE SHUTTLE LAUNCHED
- NASA LAUNCH – 1986

GALILEO

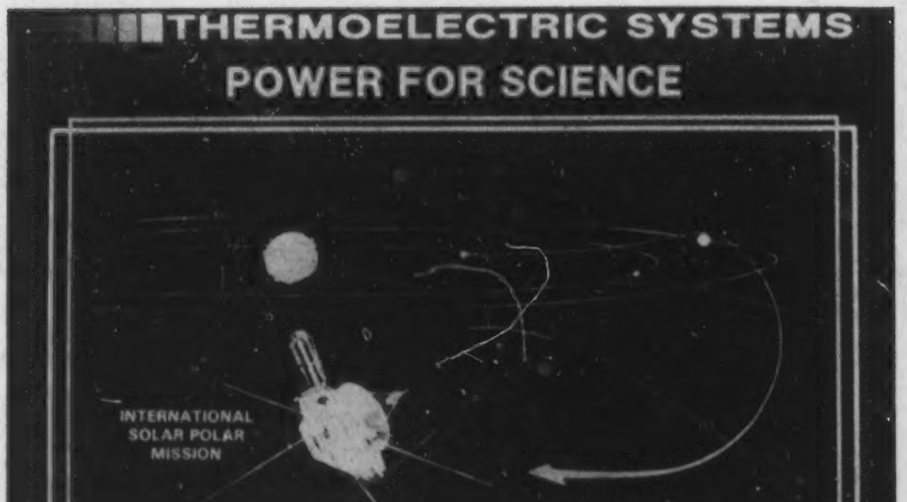
Slide 4

In spite of the fact of what looks like a decreasing budget, what we have is a situation that is the natural result of a decreasing DOE cost to produce the RTG's for the NASA solar polar and Galileo missions, and an increasing reimbursable level from NASA to cover our expenses for the actual flight units. So, the 1984 budget proposed here is adequate to meet our needs.

The major efforts—I apologize for our difficulty in seeing this. Either we're all in the dark or we can't see very well. Unless you prefer we'll proceed this way.

Mrs. BOUQUARD. The lights look better. Let's see if we can all see it better. I think that's better.

Mr. CHIPMAN. Fine.



THERMOELECTRIC SYSTEMS
POWER FOR SCIENCE

INTERNATIONAL SOLAR POLAR MISSION

- JOINT NASA-ESA EFFORT
- FIRST OUT OF THE ECLIPTIC SOLAR MISSION
- FIRST EXPLORATION OF THE SUN'S POLAR REGION
- LAUNCH 1986

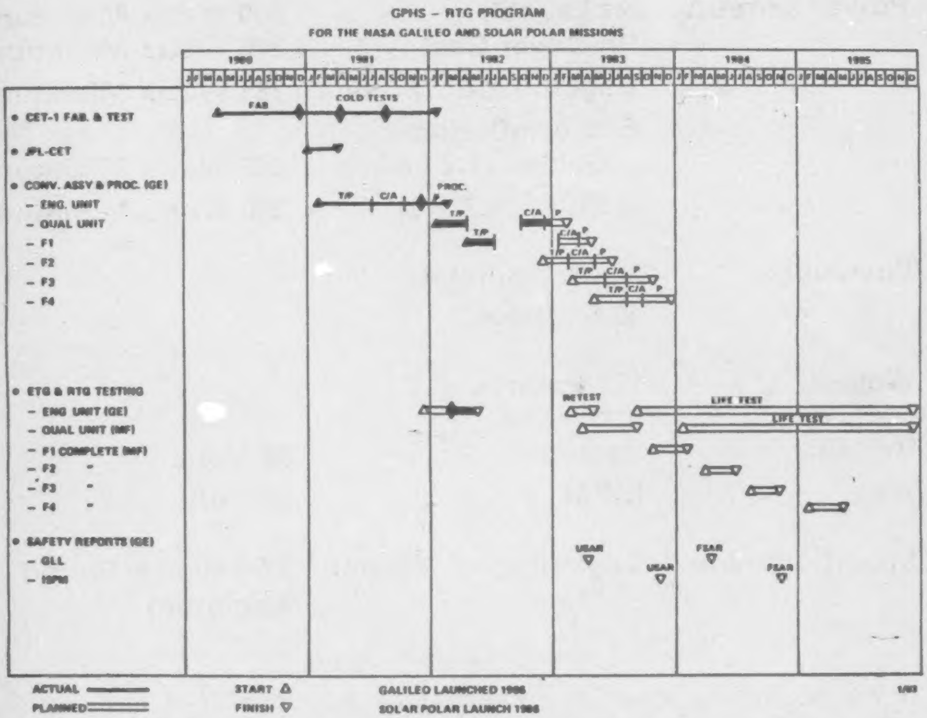
STATIC OUTER PLANETARY RTG PROGRAM

- **1 common qualification RTG Unit to be tested for both missions**
- **3 GPHS RTS's (2 flight units plus 1 spare) for planned Galileo Mission Launch in 1986**
- **1 flight GPHS RTG for planned International Solar Polar Mission Launch in 1986**

Slides 5 and 6

The RTG's that we're currently working on are for two major NASA missions. The Galileo mission, shown in slide 4, in schematic, and also the international solar polar mission, shown on slide 5. These—both of these missions require the same basic RTG's. There are slight differences in them but if we can have on slide 6, what we find is the Galileo mission requires two RTG's, and the international solar polar mission requires one RTG, as shown on slide 6. So, we have a total of three required flight units plus one spare.

These are being produced with the objective of meeting the 1986 launch date for both of these NASA missions.


GPHS – RTG PROGRAM
FOR THE NASA GALILEO AND SOLAR POLAR MISSIONS

Slide 7

If we take a look, for a moment, at the 1983-84 accomplishments on slide 7—this may be a little difficult to read—we are currently, in fiscal year 1983, in the process of assembling the conversion assemblies—power conversion assemblies—for the flight production units to meet these mission requirements. We are now about to begin a retest of the redesigned engineering unit for the one that failed last year. We had a failure in the engineering unit. It will be retested very shortly and this will be followed by a qualification fueled unit test. This unit itself is nearly finished in fabrication. We will actually begin this year to fabricate the production units—the flight units themselves. Detailed testing of these units of both the engineering and the qualification of units will begin in 1983 and carry on through 1984 and 1985. Assuming there are no other difficulties experienced, of course, the units that are fabricated for flight will be available for the actual missions themselves.

GPHS RTG PERFORMANCE OBJECTIVES

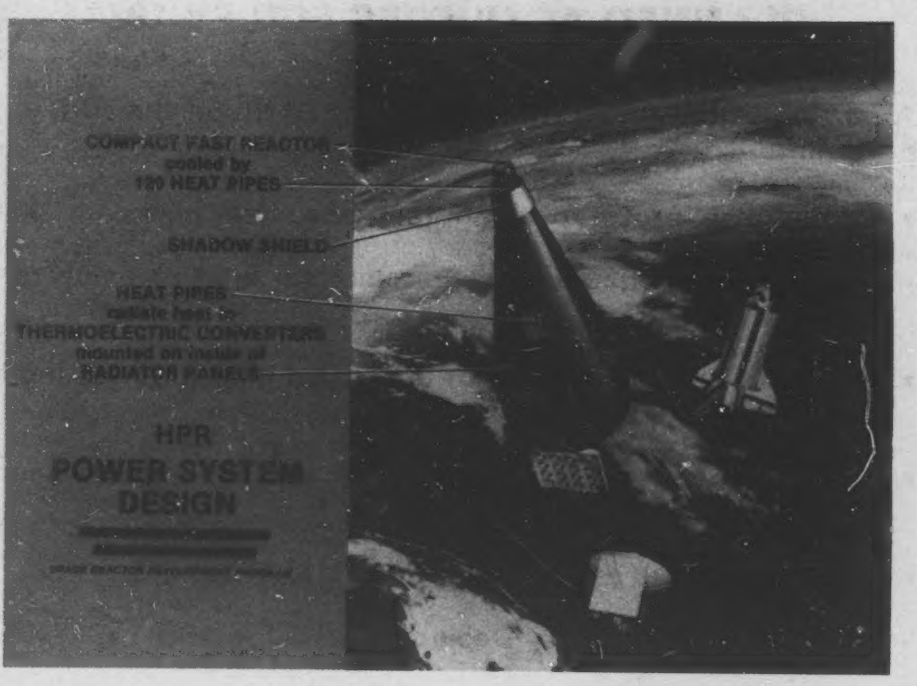
Power Output:	**At Launch (In Cover Gas)**	**200 Watts Minimum 240 Watts Maximum**
	Beginning of Mission	**285 Watts Minimum**
	End of Mission	
	Galileo (4.2 yrs)	**255 Watts Minimum**
	ISPM (4.7 yrs)	**250 Watts Minimum**
Envelope:	**18.0" Diameter 45.5" Height**	
Weight:	**122 Pounds**	
Voltage:	**Galileo**	**30 Volts**
	ISPM	**28 Volts**
Specific Power:	**Beginning of Mission**	**2.34 Watts/Pound Minimum**

Slide 8

We might just spend one moment here to look at slide 8, which shows performance objectives for the RTG's for these missions. You can see we have a pretty high power level for each of the RTG's—285 watts minimum at the beginning of the mission with a minimal decay in about 4 to 5 years at the end of the mission. I won't belabor this slide at this point.

We might move on then to talk about the program that's of great interest to everyone at this time, and that's the space reactor effort. As you know the Department of Energy began in 1979 to try to generate interest in revitalizing our work in the space reactor effort, which was stopped in 1973. I believe this committee played a role in getting the Department's interest started in this area again.

In 1981, NASA and DOE worked together awhile and came together with an understanding of how to proceed, and they were very interested in reactors for some of their potential future missions. In 1982, the Department of Defense became interested. We began work on a heat pipe reactor, prior to the signing of the recent Memorandum of Agreement, which was intended to be used for future missions, as yet undefined, and in the NASA outer planetary mission. It would have a very long life capability of about 7 years—very reliable.



COMPACT FAST REACTOR
cooled by
120 HEAT PIPES

SHADOW SHIELD

HEAT PIPES
radiate heat to
THERMOELECTRIC CONVERTERS
mounted on inside of
RADIATOR PANELS

HPR
POWER SYSTEM
DESIGN

Slide 9

Slide 9 gives an artist's schematic of what that would look like.

PLANNED ACTIVITIES FOR FY 1984

A portion of the funds will be spent at LANL on the HPR program:

- **Fabricate six prototypical 8m-long core heat pipes**
- **Complete four vacuum test furnaces for heat pipes up to 8 meters**
- **Complete first 1,000 hours of long-term heat pipe testing under design operating conditions**
- **Complete post-test analysis of IP-1A irradiation experiment (EBR-II)**
- **Install IP-1B into EBR-II, and IP-3A into FFTF**
- **Complete a Preliminary Design Reveiw for HPR**

The balance of FY-84 funds will be spent for the system integration contractor and for one or more additional reactor design contractors (based on the results of the FY-83 alternative design studies)

Slide 10

Slide 10 addresses the activity for the space reactor program that we have planned for fiscal year 1984. Focusing on the heat pipe reactor, we are planning to continue to work at the laboratory. One of our major efforts is on the heat pipes themselves. These are the key to the success of this technology, and without them we may have to go back and start all over again in terms of how we move heat around that system.

As you can see, we've had some successes in the heat pipe technology, and we are looking forward to completing the first thousand-hour test. We've also had some failures, unfortunately. We are also looking forward to installing in EBR–II and FFTF some fuel modules that will be able to give us direct data related to the reactor fuel itself. One of the concerns there is the cost of such an activity. It is rather expensive. Of course, we expect to complete the preliminary design of the heat pipe reactor.

This effort, of course, in 1983 and 1984 can be really attributed to a high degree, I think, to the efforts of this committee. You may recall in the 1981 Omnibus Budget Reconciliation Act the Department was directed to pursue this activity, and we are doing that.

TRIAGENCY MEMORANDUM OF AGREEMENT (SP-100)

- **Signed February 11, 1983**
- **Establishes DOD/DARPA, NASA/OAST, DOE/NE Relationships for Space Nuclear Power System Technology Program**

PROGRAM OBJECTIVES

Determine Potential Performance Limits

- **100 KW(e)**
- **1-100 MW(e)**

Ensure Nuclear Safety

Develop Technology for 100 KW(e) Class Space Nuclear Reactor Power System

Determine 1-100 MW(e) Class Need Support Technology

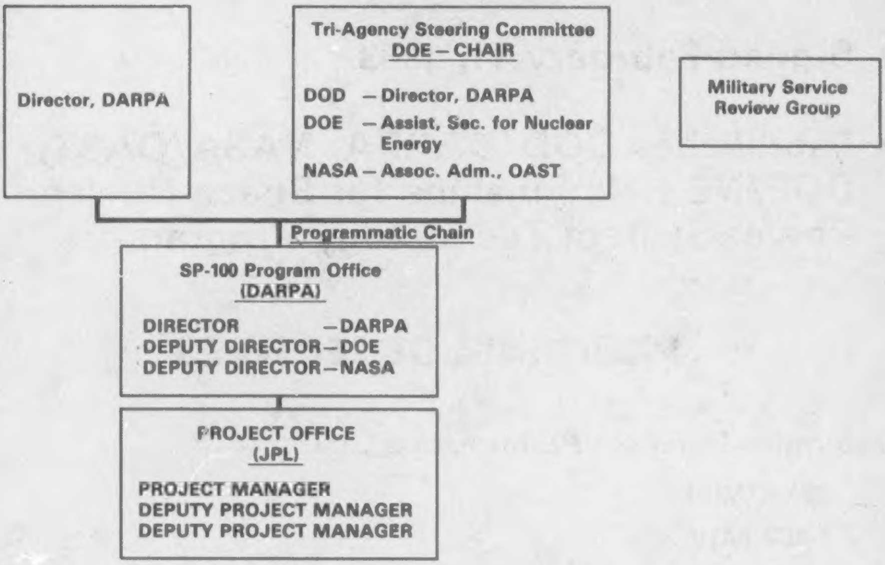
Ensure Technology Transfer to Engineering and Production

Slides 11 and 12

If I might move from the traditional budget program to discuss, for a moment, our efforts in working with the Department of Defense and with NASA in coming up with a joint program to proceed with reactor development; as shown on slide 11, an MOA—or a Memorandum of Agreement—was signed on February 11 of this year by all three agencies. This MOA established several program objectives. I've indicated in slide 12 what those objectives are primarily as they relate to the reactor itself. There are other objectives which I am sure the other witnesses will focus on, also. But, we are looking primarily at a reactor in the hundred kilowatt electric range which is, of course, very consistent with the heat pipe reactor technology that we currently have. We're going to be spending quite a bit of time trying to establish the framework—institutional and managerial framework—such that we can carry out this effort.

SPACE NUCLEAR REACTOR POWER SYSTEM TECHNOLOGY

SP-100



Director, DARPA

Tri-Agency Steering Committee
DOE – CHAIR

DOD – Director, DARPA
DOE – Assist. Sec. for Nuclear Energy
NASA – Assoc. Adm., OAST

Military Service Review Group

Programmatic Chain

SP-100 Program Office
(DARPA)

DIRECTOR – DARPA
DEPUTY DIRECTOR – DOE
DEPUTY DIRECTOR – NASA

PROJECT OFFICE
(JPL)

PROJECT MANAGER
DEPUTY PROJECT MANAGER
DEPUTY PROJECT MANAGER

Slide 13

Slide 13 is a schematic of how I envision the MOA and what it means. The MOA actually establishes the role for all three departments in managing the program.

What we have is the DARPA Agency in direct line management of the SP-100 Program Office, which is located at DARPA.

In addition, we have something that I have called programmatic chain of command here. I am sure there can be a wide range of interpretations of what that means. There is a Triagency Steering Committee made up of the senior managers involved in this program. There is the Director of DARPA, Dr. Cooper, in DOE Dr. Brewer, and in NASA Dr. Kerrebrock. This office, the way I see it at this point, is charged with broad technical oversight in the nature of review and establishment of program management plans. I believe copies of the MOA have been provided to the committee.

The project office itself would be located at JPL and both for the program office and the project office, the Department of Energy will have a Deputy Director role, whereas, for the steering committee the chairman of the steering committee will be Dr. Brewer from the Department of Energy.

If you look carefully at this, you see a mixture of responsibility from all of the agencies, and there is a sharing of responsibility and authority. The Department of Energy Deputy Director at both the program office and project office will be the principal spokesmen and the persons responsible for the reactor development itself. They report through the chain of command.

We recently completed a meeting at the Jet Propulsion Laboratory in which great progress was made in coming up with a program management plan. We have more work to do, of course, and we won't be able to speak in any great detail about how the program will be carried forward until that plan is finally completed. It's our intent to identify the DOE deputies by about the middle of this month, when we anticipate the first steering committee meeting will occur. One of the major agenda items at that meeting is to discuss the actual program management plan itself.

In early fiscal year 1983 the Department of Energy had initiated what we call phase I contracts with a number of space nuclear or reactor contractors to begin scoping out the various technology options that were available to us. At the same time, the Jet Propulsion Laboratory was preparing an RFP for contracts to be let with some of the same contractors to do related work, plus a broader look at the overall integrated mission. As a result of signing the MOA, we have stepped back from phase II for the moment. We are reassessing exactly what the Department should be doing in terms of additional work in support of the JPL contracts, which were signed, I believe, yesterday. We have the overall program right now—the overall SP-100 program has active contracts underway through JPL with three contractors in addition to the work that we have in the heat pipe reactor.

I think that's probably a reasonable summary on my part of where we stand today. I would be happy to answer questions now.

[The prepared statement of Mr. Chipman follows:]

PREPARED STATEMENT OF GORDON L. CHIPMAN, JR., DEPUTY ASSISTANT SECRETARY FOR BREEDER REACTOR PROGRAMS, DEPARTMENT OF ENERGY

Madam Chairman and Members of the Committee, I am very pleased to appear before you to present and discuss the Department of Energy's Advanced Nuclear Systems program.

The Advanced Nuclear Systems budget request for FY 1984 is $34.1 million, a decrease of $4.8 million from the FY 1983 appropriation. Distribution of the funds is as follows:

	FY 1983	FY 1984
	(in thousands)	
Advanced Nuclear Systems		
Flight Systems Development	$17,170	$14,635
Flight Systems Support	20,792	17,100
Special Applications	0	1,000
Program Direction	981	1,370
Total	$38,943*	$34,105

*Represents Department's proposed amount under the continuing resolution; may be modified by Congress.

Madam Chairman, the Advanced Nuclear Systems budget submission was given to the Committee on February 22, 1983, and contains the accomplishments planned and realized for FY 1983 and those planned for FY 1984. I would like to summarize that submission for you now.

The Advanced Nuclear Systems Program supports civilian and military space applications through the development of a range of nuclear power system options. Nuclear power sources have provided the electrical energy for the NASA Pioneer, Viking, and Voyager missions, as well as earlier lunar and earth orbital missions. Since 1961, the United States has launched 22 NASA and military space systems having all or part of their power requirements supplied by nuclear power sources.

This activity is a direct application of the nuclear expertise within the Department of Energy to support approved United States missions of the National Aeronautics and Space Administration, the Department of Defense, and other Federal users.

In accomplishing the responsibilities and in keeping with related statutory requirements, the Department and its predecessor agencies have, over the years, developed a unique complex of laboratories and personnel dedicated to nuclear space power research and development, with a strong emphasis on working within established safety and environmental guidelines. These laboratories have expertise in producing special nuclear material, forming the isotope material into the desired chemical and physical state, analyzing the materials, and testing the fueled units. Because of the potential safety concerns associated with the use of special nuclear materials, the Department, its laboratories, and contractors have developed extensive expertise, equipment, and facilities for the safe handling of this material. It is because of these unique nuclear capabilities, plus the health and safety responsibilities attendant to the use of nuclear materials, that the Department--as did its predecessor agencies--has the overall lead responsibility within the Federal Government for the development of nuclear power sources for use in space.

In fiscal year 1984, the major undertaking will continue to be the development of the nuclear isotope power generators for use on the NASA Galileo spacecraft planned for launch in 1986, and the NASA/European Space Agency International Solar Polar spacecraft also planned for launch in 1986.

Technology activities are planned to be continued towards the development of an advanced modular isotope thermoelectric generator that would enter into the ground demonstration phase. It is envisioned that this generator, with its significant improvements in modularity and high specific power to weight ratio, will be the cornerstone to support the NASA planetary and DOD missions of the future.

Another major activity is the continuation of the space nuclear reactor power development program in cooperation with NASA and DOD. The objective of this program is to develop space nuclear reactor power sources capable of producing 100 kilowatts or more of electrical power. NASA missions involving nuclear electric propulsion, space stations, lunar operations, and planetary exploration and DOD applications involving communications, surveillance, electronic jammers, and space command defensive weapons will require power levels in this range.

As you know, last month a Memorandum of Agreement (MOA) was signed by DOE, DOD, and NASA that established procedures whereby these agencies will jointly develop the technology necessary for space nuclear reactor power systems. This MOA sets up a management structure, assigns various responsibilities to the several agencies involved, and establishes funding committments. Under the terms of the MOA, the Department of Energy becomes chairman of a program steering committee, and provides a Deputy Program Director and Deputy Project Manager to work with the other agencies in managing SP-100 program activities. We are now working with NASA and DOD to implement this program.

Madam Chairman, that completes my prepared remarks. I would be happy to answer any questions you might have.

Mrs. BOUQUARD. Thank you very much, Gordon. We would also like to have these charts for the record, if you would please supply them.

I'm going to limit my questions right now on RTG and will defer the questions on the Memorandum of Agreement until we have the panel.

I think also for the record, since so many members of the committee are not here today, and we have two or three subcommittees going on at the same time, I think it would be useful if you would give us a brief description of what RTG's are, how they work, and how they intend to be used.

Mr. CHIPMAN. Yes, ma'am, I can do that but I think it would be worthwhile if Mr. Bernard J. Rock, who has been involved for many years in developing this technology would do this for you.

Mrs. BOUQUARD. I felt that that might be his mission here today.

Mr. ROCK. Madam Chairman, the basic principles of the RTG are quite simple. We use the radioisotope to generate the heat energy and then convert that thermal energy into electricity with thermoelectric couples, i.e., static conversion devices. The plutonium that we use in the RTG's, primarily for the space missions, is plutonium 238. This isotope has a very long half life—over 87 years long—so in each year there's only 1 percent of that heat energy that decays. With that heat energy, within the generator, we are able to convert that heat energy into electricity through the use of these thermoelectric elements. These static devices are able to produce the electricity for the spacecraft for very long periods of time.

Mrs. BOUQUARD. The decay is more minute, would you agree?

Mr. ROCK. Ma'am?

Mrs. BOUQUARD. The decay is not an overriding factor then because of the long——

Mr. ROCK. That's right. In most of our space missions we're targeted for power systems that have to work for some 4 to 7 years and so the amount of heat energy that decays is very small compared to the lifetime of the entire mission. That provides us with a very good source of thermal energy. The laboratories are able to produce the fuel and are able to quantify the amount of material and the thermal energy that goes into these devices in very small increments—in the range of about 10 or 15 thermal watts—so that the device has essentially a constant thermal output or essentially, its own sun, and uses that energy to change it into electricity with the thermal electric devices in there.

Mrs. BOUQUARD. Would you briefly give the uses for this?

Mr. ROCK. Well, Gordon mentioned that back in the early fifties the Department started the program on radioisotope thermoelectric generators and the first systems that were launched were aboard DOD spacecraft—they were called the Transit Series—and they demonstrated this capability to take this radioisotope heat and convert it into electricity. These early devices were about 2½-watt electrical units, compared to the units that are now flying on the NASA Voyager spacecraft that produced approximately 150 watts of electricity. In addition, a series of demonstrations of that technology were also done in a series of terrestrial program activities wherein strontium-90 fueled generators, using an isotope to provide the thermal energy source, were built and provided electricity to such things as deep ocean beacons, weather buoys that were stationed in the Gulf of Mexico, provided electricity for lighthouses—one of the experimental lighthouses was in the Chesapeake Bay—and even did some experimental work with Coast Guard buoys providing the electrical energy for the fog horns and the lights out on the Chesapeake Bay. The isotope thermoelectric technology is well established now on using this kind of converter technology. The programs that we envision in the future will use this kind of technology both from the space side and in the terrestrial applications. There are a number of potential applications in the future in both of these areas.

Mrs. BOUQUARD. You mentioned earlier that although the program was moving ahead, the budget was declining for the program. What will be the funding—as you foresee it—beyond the 1984 budget? Is there intent to phase out the R&D work in this area? How do you see the budget posture in future years?

Mr. CHIPMAN. The budget required to complete the flight units for the RTG's for Solar Polar and Galileo will phase out. We do have, however, a standing request to continue development of improved, more efficient RTG's. This committee has asked us to do that and there are future NASA and DOD missions which may require these advanced convertors or RTG's. That program will continue on a scale which really is commensurate with user needs. Right now we have a fairly stable program in that area, and I foresee it continuing that way for some time. But, it's a program we really need to assess on a yearly basis—depending on how much progress we've made and what the future missions are.

Mrs. BOUQUARD. I understand that the reductions were in the fuel fabrication work and the support and safety features of the program; is that correct?

Mr. CHIPMAN. There was a problem in the original 1983 budget request in that the independent quality assurance, or QA, was severely reduced and much of the technical support activities were way below what we considered to be an acceptable level. As a result of the continuing resolution, however, our budget as proposed is adequate to restore these and the advanced work, which was zeroed out of the 1983 request to meaningful levels, which are consistent with the program historically and consistent with our future needs.

Mrs. **Bouquard**. I belive the continuing resolution had about $4.8 million for RTG work. Is this the money that you are referring to?

Mr. **Chipman**. Yes, ma'am.

Mrs. **Bouquard**. How do you intend to use these funds?

Mr. **Chipman**. It will be used to support the independent QA work to a higher level that's more consistent with the needs for the technical support activities. It might be worthwhile if I ask Mr. Rock to give you some specifics on that.

Mrs. **Bouquard**. Mr. Rock.

Mr. **Rock**. One of the areas that we've restored is the operational safety and testing analysis work that was constrained in the earlier budget submission, and that's about half of those funds—of the $4.8 million. Of the other remaining funds, there's about a fourth of it that's going for capital equipment in support of the production program for both the Galileo and the Solar Polar production operations. About a third is going into the advance work that Gordon mentioned, on the advanced modular generator activities. The remainder is for the technical support and quality assurance area.

Mrs. **Bouquard**. Gordon.

Mr. **Chipman**. Madam Chairman, I might add that, as part of the submission to Congress on what we intended to do with the 1983 budget, we did receive a letter from the House Appropriations Committee putting a hold on both this $4.8 million and also some additional space reactor money that we deemed to be appropriate and necessary until the MOA was signed. It was interesting to note that the letter out of the committee was dated the same day that the MOA was signed. We are in the process now of trying to resolve that. We have a letter inhouse that is ready to go—it may have even gone today—to Chairman Bevill, and we do have hopes of resolving that matter in the near future.

Mrs. **Bouquard**. Our mail has been being held up about 2 weeks around here, we've had such an influx of mail. I think it's probably a good thing if your mail is not held up on this particular resolution.

Thank you very much. I believe now you are going to be joined by Dr. Kerrebrock and Dr. Cooper.

Dr. Kerrebrock, I believe you go first. Please proceed. You may proceed with your testimony, as you wish, or you may summarize. Your complete testimony will be made a part of the record.

STATEMENT BY JACK L. KERREBROCK, ASSOCIATE ADMINISTRATOR, OFFICE OF AERONAUTICS AND SPACE TECHNOLOGY, WASHINGTON, D.C.

Dr. **Kerrebrock**. Thank you.

I am pleased to appear before you today to discuss the NASA efforts and interests in space nuclear power sources. Such sources are essential for missions which call for power in the absence of sunlight, or in the presence of intense radiation environments for which the traditional solar array/battery systems are unsuited. There are two general types of nuclear power sources of interest to us: radioisotope thermoelectric generators [RTG's], devices used by NASA for relatively low power mission requirements, and nuclear fission reactor power systems, which we consider enabling for some future high power applications. I shall discuss these two types of systems separately as they involve different technologies and are at different levels of technology readiness.

The next planned use of the RTG's is in connection with the NASA Galileo and the International Solar Polar Mission [ISPM], which are planned to be launched by the shuttle in 1986. They will obtain all of their electrical power from RTG's that are under development by the Department of Energy [DOE]. A Memorandum of Understanding [MOU] is in place between NASA and DOE to support these two important missions. Currently, DOE will provide three flight isotope units and one common flight spare to NASA on a reimbursable funds transfer basis. In keeping with the intent of the Congress to have NASA reimburse DOE for the isotope qualification test unit and the flight isotope spare unit, NASA has requested additional resources of $13 million in the fiscal year 1984 Planetary Exploration budget to accommodate this item. Our respective staffs are working out the details of the revised interagency agreements and subsequent funding transfers.

As you probably are aware, the electrically heated engineering converter failed to pass the qualification vibration level tests to which it was subjected. The qualification vibration levels caused movement in an insulation support cage that led to fracture of several thermoelectric elements. As a result, engineering changes have been made and we understand that the Department of Energy plans to retest this modified converter within the next few months. Both NASA and DOE are in agreement with the failure analyses conducted and the engineering modifications undertaken to prevent cage movement. In the meantime, the qualification converter has been modified, fabricated, and assembled as an electrically heated unit; its testing as an isotope-fueled unit is planned to be completed this fiscal year. We look forward to the successful completion of those two critical tests.

In light of the present technical situation, and because of the importance of maintaining the delivery schedule of the flight isotope power units, both NASA and DOE have been working together to minimize any schedule slippage.

Let me turn to the nuclear reactor power systems now. There are a number of potential missions—I underline the word "potential"—which will have energy demands much higher than any past mission. I would like to cite deep space missions as an example: Voyager II will consume approximately 20,000 kilowatt-hours during its lifetime, while a Neptune Orbiter or Saturn Ring Exploration mission would demand upwards of 5 million kilowatt-hours. Clearly, a different type of power system than the RTGs will be necessary to meet these demands. The system will potentially have to supply large amounts of power for long periods of time, with minimal sunlight, and in an intense radiation environment. Furthermore, the power should be supplied at a cost much lower than the present cost of RTG's in order to be affordable. In our judgment a nuclear fission reactor system could be suitable for such missions, which include lunar and planetary bases, advanced manned space platforms as well as several potential military missions, to which, I'm sure, Dr. Cooper will refer. We believe that such possible missions provide incentive for technology advancement which will enable full scale development at the appropriate time.

It should be noted that no serious technology effort has existed in this area since the early seventies, apart from a low-level research program in advanced thermal to electric energy conversion conducted by NASA, and a modest effort in reactor technology started by the DOE in 1979. In 1980 a triagency [NASA/DOD-DOE] working group concluded that the advent of the operational space shuttle will enable the planning of some missions requiring nuclear reactor power sources—and they recommended a focused critical technology effort in the area. As a consequence, negotiations among the agencies began. I am pleased to report that, after considerable deliberation, these negotiations have been concluded, and a triagency memorandum of understanding was signed on February 11, 1983, by me for NASA, by Dr. Brewer, Assistant Secretary of Nuclear Energy for the Department of Energy, and by Dr. Cooper, the Director of DARPA for the Department of Defense.

This MOU covers the technology assessment and advancement phase which will be a truly joint effort and will, at modest cost, enable an intelligent and informed decision to be made in 1985 or 1986 as to whether there are both clear mission requirements and a sufficient technology base to embark upon a ground demonstration experiment. The funding commitments by the three agencies are included in this memorandum of understanding, and are broken out in my prepared statement.

Mrs. BOUQUARD. That will be made a part of your record, Dr. Kerrebrock.

Dr. KERREBROCK. The management structure provides for a steering group, chaired by the Department of Energy, to be responsible for policy; a program office, headed by DARPA, to be responsible for planning and budgeting; and a project office at NASA's Jet Propulsion Laboratory to be responsible for technical planning and execution of those plans. While retaining the essential features of a single line management, this approach permits each agency to be represented and fully involved at each level. The plan calls for mission definition studies, both civil and military, the assessment of the state of the art, and the advancement of critical technologies. Industrial participation will be encouraged throughout. To this end, the plans call for a significant percentage of the funds to be spent in industry. At the same time, in-house expertise of the key Government laboratories will be utilized and enhanced. The major participants are expected to be Los Alamos and other national laboratories, JPL, Lewis Research Center [LeRC], and cognizant military service groups.

This organization may appear complex, but it reflects the complexity of the technology and the need to involve users in its development in order to ensure that system constraints are properly treated. It is an inescapable fact that while the nuclear reactor is at the core of the power system, it interacts so strongly with the whole spacecraft that all technologies and interfaces must be considered in an integrated and interactive manner from the beginning. Moreover, flexibility to adapt and change technologies is imperative while missions are being defined. In our judgment, this is a workable approach to ensure that realistic mission requirements are evolved and can be met with acceptable technological risks. It assures that there will be both Government and industrial capability to respond to those requirements.

Finally, I would like to point out that this plan also permits us to place maximum emphasis on safety. Safety analyses will be carried out from the beginning and will have a heavy impact on mission definitions as well as an impact on the possible decision to proceed with development. We would be pleased to provide more detailed briefings for the members of your staff if you so desire.

I conclude with that and thank you.

[The prepared statement of Dr. Kerrebrock follows:]

Statement

of

Dr. Jack L. Kerrebrock
Associate Administrator for
Aeronautics and Space Technology

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

before the

Subcommittee on Energy Research and Production
Committee on Science and Technology
House of Representatives

Madam Chairman and Members of the Subcommittee:

I am pleased to appear before you today to discuss the National Aeronautics and Space Administration's efforts and interests in space nuclear power sources. Such sources are essential for missions which call for power in the absence of sunlight or in the presence of intense radiation environments for which the traditional solar array/battery systems are unsuited. There are two general types of nuclear power sources of interest to us: radioisotope themoelectric generators (RTGs), devices used by NASA for relatively low power mission requirements, and nuclear fission reactor power systems, which we consider enabling for some future high power applications. I shall discuss these two types of systems separately as they involve different technologies and are at different levels of technology readiness.

Radioisotope Thermoelectric Generators

The next planned use of RTGs is in connection with the NASA Galileo and the International Solar Polar spacecraft, which are planned to be launched aboard the Shuttle in 1986. They will obtain all of their electrical power from Radioisotope Thermoelectric Generators (RTGs) that are under development by the Department of Energy (DOE). Memoranda of Agreement are in place between NASA and DOE to support these two important missions. Currently, DOE will provide three flight isotope units and one common flight spare to NASA on a reimbursable funds transfer basis. In keeping with the intent of the Congress to have NASA reimburse DOE for the isotope qualification test unit and the flight isotope spare unit, NASA has requested additional resources of $13M in the Fiscal Year 1984 planetary exploration budget to accommodate this item. Our respective staffs are working out the details of the revised interagency agreements and subsequent funding transfers.

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Nuclear Reactor Power Systems

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The MOA covers the technology assessment and advancement phase which will be a truly joint effort and will, at modest cost, enable an intelligent and informed decision to be made in 1985 or 1986 as to whether there are both clear mission requirements and a sufficient technology base to embark upon a ground demonstration experiment. The funding commitments by the three agencies for this phase are as follows:

Current Year $M

	FY82	FY83
DARPA	2.0	4.0
DOE	1.3	2.5
NASA	2.4 (+5dmy*)	2.9(+10dmy)
Total	5.7	9.4

	FY84	FY85
DARPA	5.0	8.0
DOE	4.1	4.1
NASA	3.9 (+10dmy)	3.9 (+10dmy)
Total	13.0	16.0

*dmy - direct man years

These commitments are, of course, subject to the normal Executive and Legislative review process.

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Thank you for the opportunity to discuss these matters with you.

Mrs. **Bouquard**. Thank you very much, Dr. Kerrebrock. I do apologize because we do have so few members here today, but I think most of you realize that at this time of budget plans we have about three subcommittees going on at the same time. We are very happy that one of our new members, Congressman Valentine, is with us today. He is working hard with us on this committee, and we look forward to a long future with Congressman Valentine.

You mentioned the interface between NASA and the Department of Energy. How do you work to make sure that you do have the appropriate level of reliability and the quality control that you need in this arrangement to see that you have the flight-worthy RTG systems that you must have, and that they are maintained?

Mrs. **Bouquard**. How do you break this off?

Dr. **Kerrebrock**. NASA has a well-established system for insuring reliability in flight systems, which goes from a thorough set of reviews in the technology and design phases of all such programs through a critical design review, which comes just prior to the building of any piece of space hardware. It would be our intention to assure that, along with DOE, we implement that kind of quality control in this program. I believe that it is safe to say that the DOE, on its side, has a comparable system of quality control for the nuclear elements of the system. We would rely on them for that. For the parts that we are responsible for, we would implement such a quality control system. Nuclear safety is basically the responsibility of the DOE.

Mrs. **Bouquard**. So the individual responsibilities are broken down to the department?

Dr. **Kerrebrock**. I believe so; however, all work is under the coordination of the program and project offices.

Mrs. **Bouquard**. Do you feel that there are applications for RTG's in the civil space program beyond these missions?

Dr. **Kerrebrock**. We do not have defined requirements for RTG's beyond Galileo and ISPM at the present time. However, I think that while it is clear that there will be such requirements at low-power levels where the reactor system is not justified or required, I cannot tell you exactly what those will be at this point.

Mrs. **Bouquard**. Mr. Valentine?

Mr. **Valentine**. Madam Chairman, as you know I just got here and I didn't think that I would ask any questions but I decided that I would make this inquiry, and if it's—if you don't care to answer it I'll understand. I just left my office and a large number of people were around there about this so-called nuclear freeze situation.

Would you care to express an opinion as to whether or not, if you were a Member of Congress, you would support that sort of thing?

Dr. **Kerrebrock**. The nuclear freeze?

Mr. **Valentine**. Yes, sir.

Dr. **Kerrebrock**. No, sir, I would not care to comment on that at this time. Not in this hearing.

Mr. **Valentine**. Thank you very much. I don't blame you.

Mrs. **Bouquard**. Thank you very much, Mr. Valentine.

Dr. Cooper, please proceed with your testimony.

STATEMENT OF ROBERT S. COOPER, DIRECTOR, DEFENSE ADVANCED RESEARCH PROJECT AGENCY, ARLINGTON, VA.

Dr. **Cooper**. I'm happy to be here this afternoon to support DOE's authorization request for space nuclear power, particularly in the area of our new program, the SP-100. I'd like to do a couple of things. I'd like to, if you agree, submit a short statement for the record that outlines——

Mrs. **Bouquard**. Your complete testimony will be made a part of the record.

You may proceed as you wish, Dr. Cooper.

Dr. **Cooper**. Thank you very much.

I'd like to make a few comments, if I might, before answering any questions you may have.

First of all, this is the first time in my recollection that anyone from DARPA has testified before this committee. I would like to tell you a little bit about what the Defense Advanced Research Project Agency is; what role it may play in the development of space nuclear power; and what I feel may be some imperatives for the development of space nuclear power for military applications in the future.

First of all, DARPA was an organization that was chartered by the Secretary of Defense in 1958, when sputnik was launched by the Soviet Union. Partly in response to the concern that existed in the Nation at the same time, NASA was also created. Many of the early projects that the Secretary gave to DARPA to pursue dealt with space and space-related activities. Many of these projects now are completed and are part of our space arsenal—both our civil and our military arsenal as a matter of fact. The charter of DARPA is to do high-risk, high-payoff contract research. We are attached directly to the office of the Secretary of Defense, not to any military service. We're very small; we have about 100 scientific and technical staff with about 50 support people. Out of DARPA down through the 25 years of its existence have come some of the most innovative research activities in the Defense Department and some of the most interesting military applications of research and development. We're happy to join with NASA and the Department of Energy in space nuclear power development after a hiatus of over a decade in the development of space reactor power at high-power levels. We believe that now is a very propitious time to engage in this kind of research activity because the interest is building in applying high-powered electrical systems to military space missions as well as to some civil missions.

I think the thing that DARPA brings to the table in this triumvirate is a strong interest within the Defense Department in high-payoff advanced technology and that it has no particular need to have a stated military requirement in order to engage in research. It just needs the perception that there may be a high military payoff and the acquiescence of the Secretary. I can assure you that we in the Defense Department are ready to proceed with this program, and fully intend to hold up our end of the bargain that we have made with NASA and with the Department of Energy.

DARPA does have substantial resources and we can bring those resources to bear, depending upon how encouraging our research activities in this area turn out to be. We have no bureaucracy; we can move very quickly and consequently we have taken on the responsibility at the behest of the others to take the leadership in bringing the program quickly into being and to move out.

Mrs. **Bouquard**. That is very encouraging to know that you have no bureaucracy, you have sufficient funds, and you can move ahead without a mission. That's great.

Dr. **Cooper**. That's right.

Mrs. **Bouquard**. That's what we've been looking for. You should have been before this committee a long time ago.

Dr. **Cooper**. Not only that, but DARPA down through the years has developed excellent and close relationships with the military services and can anticipate their needs for the future. As a matter of fact, one of our major endeavors is to anticipate future military need and to assure that technology is in the pipeline to be exploited by the services at the appropriate time in the future. We have, therefore, a very good view of future military need, and I think we can bring that to bear in this program to help define its directions in relationship to military need.

I'd like to address two issues which I know are of interest to the committee which relate to this program. One is potential military applications and the other is the idea of protection of the civil applications. First of all, there is no current formal military requirement that has been stated by the military services for space nuclear power in a category that would result from this technology program. We believe that future needs abound, and I believe that there is a good deal of consensus within the military services that this is a good prospective area for high technology at this stage.

Moreover, last summer there was a study by the Defense Science Board, which is the principal scientific body which gives advice to the Secretary of Defense, naming space nuclear power as one of the 17 highest payoff technologies for defense to pursue in the near future. It recommended a strong program in this area.

Some of the missions that the Defense Science Board outlined in support of its contention that space nuclear power would be useful for defense in the future were such mission areas as a space-based radar system. There is strong interest in defense today to apply space-based radar technology to a wide variety of military problems that are of paramount importance. Key among those are the current interest in strategic defense and defense of the continental United States against bomber attack, which we have neglected for about 15 to 20 years.

Second, the application of space-based radar defense of the naval battle groups, as they roam the world, to defend them against air attack. Space-based radar has a high potential military payoff in the judgment of the Defense Science Board and also in my judgment, and it will require major new advances in technology, both in the space systems and in the electrical power systems available.

Mrs. **Bouquard**. Is the Soviet Union progressing with this technology?

Dr. **Cooper**. The Soviet Union does have a space-based radar that they use for battle group surveillance. They search the surface of the ocean, in an ocean surveillance mode, and with systems of this sort they are able to track our capital ships using radar. We have currently no radar in orbit for military purposes.

Our view is that in the more distant future radars with power aperture products on the order of 10 to 100 million watt square meter power aperture products will be necessary in order to meet military requirements. Typically, one can consider putting structures in orbit that are on the order of tens of meters in physical size. So, that means that in order to get to the power aperture products required we will need hundreds of kilowatts of electric power available in space.

Today, radioisotope thermoelectric generators are unable to achieve those power levels, and solar array battery systems that are the prime source of spacecraft power today would be very expensive and unwieldly in order to supply this kind of power. We feel that only space reactors could supply powers in this range.

Another interesting application of high-power capacity in space is to provide refrigeration for infrared surveillance systems. Another technology that DARPA is working on vigorously is advanced infrared surveillance technology. We are producing infrared surveillance focal planes today that are massive in size and dissipate enormous amounts of power in the focal plane. This power has to be pumped from the focal plane at temperatures approaching absolute zero. It's an interesting quirk of nature that in order to make things cold you have to first make things hot, and that's where the space reactor may come in. We believe that refrigeration capacities required by advanced surveillance systems that would increase the capability of our ballistic missile early warning or perhaps make it possible for us to detect aircraft and surface objects of military importance in the future may require the kind of refrigeration capacity that only a nuclear heat source could provide.

Another important potential application for the future in the military regime is high-power communications. Typically, our space communication systems have been limited by the fact that only small powers are available from solar array battery systems. If we had tens to hundreds of kilowatts of electric power available for our communication systems it would open up new vistas for securing our military communication systems against enemy actions—jamming and other potential actions. In addition, DARPA is working on an advanced laser communication system that will allow us to communicate with our submerged submarines anywhere in the world while they are under water with blue green lasers. Blue green lasers have the salient feature that their light can be transmitted to great depths within the ocean. That's why the oceans are green. We believe that if we could place lasers with radiated powers on the order of kilowatts of optical power into satellites that we would be able to provide secure communications to our ballistic missile and attack submarines anywhere in the world.

Because lasers are inefficient in their conversion of electric energy to optical energy, a few kilowatts of optical power may require as much as a few hundred kilowatts of prime electrical power to drive them. Only space nuclear power systems, I believe, could provide that kind of power. For the more distant future, DARPA is also working on laser and particle beam weapons which may be required in space in the future for military purposes. If these systems are put in space, if they are needed, and if we determine that our national security can only be protected if we have them, then we may have requirements for space nuclear reactor systems that will produce megawatts to hundreds of megawatts of power in the more distant future. So, one of the objectives of this program would be to determine where the technology boundaries for space nuclear power may be and what near-term technology needs to be done in order to enable the possibility of our creating such major power systems in space for the future.

Typically, as you heard from the DOE testimony earlier, many of the applications in space first are done for military purposes. For instance, you heard that the first radioisotope thermoelectric generators were placed on military navigation satellites—the Transit Series. So, I believe that the first applications of space nuclear power in the power range that we are talking about here are likely to be military applications. We recognize that there are potential civil applications of nuclear power systems in that same range. DARPA has a long history of working both with NASA and with the Department of Energy on programs that have this dual use—that is, both military and civil applications.

I am sure that we can work with our two partners in this endeavor to protect the civil applications of space nuclear power even though we recognize that military applications may come first. I would like to again urge you and the committee to support DOE's authorization request because it will be a key element in the SP-100 space nuclear power program as we move forward, and we feel that there will be strong military reasons to have this technology available in the 1990 time period.

Thank you.

[The prepared statement of Dr. Cooper follows:]

PREPARED STATEMENT OF DR. ROBERT S. COOPER, DIRECTOR, DEFENSE ADVANCED RESEARCH PROJECTS AGENCY

MADAM CHAIRMAN AND MEMBERS OF THE SUBCOMMITTEE:

I am very pleased to have the opportunity to appear before you at this very exciting period in the development of space nuclear power for eventual civil and military applications. As you are well aware, the Department of Energy's Office of Nuclear Energy and the National Aeronautics and Space Administration's Office of Aeronautics and Space Technology joined forces with DARPA on 11 February 1983 to create the SP-100 Program. We at DARPA and the Department of Defense are quite excited about the prospects of working in a closely knit, cooperative fashion with the Department of Energy and NASA. We live in an era of space research, exploration, and exploitation when the demands from space mission planners for ever increasing levels of power are frequent and when the limits of conventional space power technologies are being felt daily. While we can point to no formal, firm military space mission requirements for the high power capabilities afforded by nuclear systems, it is becoming increasingly evident to the members of the military space community that a variety of critical missions of the future may well depend on the successful development of space nuclear power systems.

As examples, it is straightforward to calculate the increased performance given by high power to space radar systems or other space sensors in the increasingly crowded and complex strategic and tactical battle environments. If we could reach a power aperture product of 10-100 megawatt-meter^2 for space radars then we could begin to detect and track on a wide area basis the small radar cross section missile and aircraft threats facing us today and in the future.

Perhaps an even more important payoff for space nuclear power from the viewpoint of the military planners is the potential for increased robustness and survivability in a wartime space environment. The defense capabilities which we have gained over the past two decades by our use of space have become increasingly important in our strategic and tactical defense plans. We can ill afford to give these capabilities away early in a conflict through failure to make use of new technologies to increase survivability. Space nuclear power appears to offer survivability advantages in terms of hardening against a variety of attacks. Moreover, some of the additional power available could be used for increasing survivability of space systems. Perhaps harder but less energy-efficient electronics could be used if we were not so terribly constrained by current power availability.

While we are certain the military payoff from space nuclear power could be very substantial, development of a specific, fixed mission requirement is still by no means certain. Until the technology and system concepts are more certain and compelling, space planners, who must solve today's problems, cannot count on the availability of space nuclear power. However, without substantive input from the users, technology and systems development will probably fail to move in directions most likely to support evolving needs. This gap between user and developer has been one of the major obstacles to exploitation of space nuclear power in the last two decades.

In the Department of Defense one of DARPA's major roles is to help bridge this gap by developing technology with high potential military utility but with technical risks, costs, or development time incompatible with the military services R&D programs. Of course it is then our responsibility to work closely with the military services to ensure we are proceeding in the proper direction, to make the user part of the process from the beginning, and to maximize the likelihood of eventual transfer of the technology to operational systems. In this particular program, the process of bringing the military services into the process early and fully has been underway at DARPA for more than a year at the working level. I am also planning to establish a senior level service review group to ensure that directions taken by the SP-100 Program are appropriate to our national security needs and that information on progress and results is readily available to our top military planners.

As attractive as the concept of space nuclear power appears to be for future military use of space, we must keep in mind that the technology and engineering development path will be arduous, complex, and expensive. Moreover, in addition to military users, there are a wide range of civil near-earth and deep-space missions which can be enabled or radically enhanced by this technology. Therefore we can expect to achieve a successful conclusion of our efforts over the next few years only if we are careful to ensure that technology we develop is suitable for a range of civil and military missions and if we are careful to draw upon the best technical and management talent in the areas of expertise represented by the three parties to the Memorandum. We at DARPA feel strongly that the partnership we have entered offers the very best possibility of success.

As you know, the Memorandum of Agreement stipulates that SP-100 will be run by a Program Director from DARPA reporting to me and receiving programmatic direction from a tri-agency Steering Committee chaired by the Department of Energy. DARPA is fully committed to supporting this program and has established a SP-100 Program Office for the Director and his deputies from DOE and NASA. I will be recommending to the Steering Committee for approval one of our most capable technical managers who has demonstrated remarkable effectiveness in managing complex programs and in interacting with the military services.

I am most gratified with the selection of NASA's Jet Propulsion Laboratory to act as the Project Management organization for

SP-100. I am confident that they will ensure that technology developed under SP-100 will be fully compatible with the complex task of integration into space systems, and that these space systems will meet or exceed the evolving military and civil mission requirements. JPL's past experience in planning and conducting highly successful, complex space missions and their in-house technical capabilities and experience brings us a valuable center for long-term technical continuity to work with the government team.

It is important to complement JPL's Project Manager role with an equally competent, experienced and respected center for nuclear technology. We are looking forward with enthusiasm to DOE's recommendation to the Steering Committee of an organization to fill this critical role in partnership with JPL.

While the detailed technical plans and objectives of the program are being defined and will be presented to the Steering Committee shortly, some elements of the overall plan are clear from the MOA and past efforts. SP-100 will concentrate on system concepts and technologies in the 100 kilowatt class (say, 20 to 500 kilowatts depending on the selected mission requirements). There are many civil and military applications which could be addressed in this range, including communications, sensors and electric propulsion for orbit transfer and deep space missions.

Further term applications may also exist in the range of 1 to 100 megawatts and more. Applications here range from very high power sensors and propulsion systems to space weapons systems. The specific missions are less clear and farther off than for the 100 kw class concepts. Also, some of the missions involving short total operating times may be amenable to non-nuclear approaches. We will not be starting a significant technology demonstration program in high power nuclear technology unless and until we can see that nuclear concepts offer significant advantages for specific missions which have a reasonable chance of success. The process of sorting out the payoffs and requirements for multi-megawatt space nuclear power systems was started last week at a government workshop at JPL. Participants included service members as well as technical program personnel. We expect that concentrating on the 100 kw class technology will provide an evolutionary means of addressing the higher powers in the future. This is not to say that we expect one system concept to perform efficiently at both ends of the power spectrum, but that much of the fundamental technologies and system design experiences will be applicable.

We all must continue the level of commitment expressed in the MOA and must focus our attention on the key mission utility, space systems, and nuclear and non-nuclear technology issues. If we can do that, transition to a 100 kw ground test program could proceed in perhaps three years and a space nuclear power system should be available on a timescale to meet evolving military and civil needs.

Thank you again for the opportunity to address the committee on this important space nuclear power technology development program.

BIOGRAPHICAL INFORMATION

ROBERT S. COOPER

DIRECTOR, DARPA

EDUCATION:

Bachelor Degree, Electrical Engineering, University of Iowa
Master Degree, Electrical Engineering, Ohio State University
Doctor of Science Degree, Electrical Engineering, Massachusetts Institute of Technology

ACADEMIC HONORS:

University of Iowa Graduate with Distinction
Ohio State University Westinghouse Fellow
M.I.T. Ford Foundation Post Doctoral Fellow

EXPERIENCE:

August 1981 to present
Director of the Defense Advanced Research Projects Agency. Chief executive officer of an independent Defense agency responsible for research and exploratory developmental concepts that are not yet identifiable with a specific military requirement or Service mission, or which relate to the function of more than one Military Service. Provides technical direction and establishes management policy for an agency of about 145 people conducting R&D projects totalling more than $700 million per year.

1979-1981
Vice President, Engineering, Satellite Business Systems. In charge of all research and development of an advanced, digital, burst communication system employing satellites and customer premise earth stations to provide integrated voice, high speed data, electronic mail and video teleconferencing services to SBS customers.

1975-1979
Director of NASA Goddard Space Flight Center. Chief executive officer of an organization employing 3,700 scientists, engineers and support personnel engaged in space related research and development projects at an expenditure rate of about $800M per year. Job involved setting policy and determining direction of major research programs, garnering NASA, White House and Con gressional support for these programs and directing their execution. Responsible for launch vehicle operation employing the Thor-Delta launch vehicle at an average rate of 10-12 per year from both Eastern Test Range and Western Test Range. Also responsible for worldwide satellite tracking system and NASA communications (NASCOM). Some representative Goddard research programs were: Space Science research in astronomy, astrophysics, magnetospheric physics, infrared and ultraviolet observational equipment, high energy physics and astronomy. Applied Science research in atmospheric observation from space and weather prediction, geophysics, oceanography, land observation from

space and advanced earth observational instrument development. Engineerin research in spacecraft stabilization and control, propulsion, materials, data processing and analysis, and communications.

1972-1975
Assistant Director of Defense Research and Engineering, Department of Defense. Set policy, established DDR&E program direction, budgets and monitored programs in Defense Satellite Systems, High Energy Laser Weapon programs, Defense Mapping Agency, and provided DDR&E coordination with all intelligence-related R&D.

1968-1972
Staff member, Group Leader and Division Director at MIT Lincoln Laboratory. Participated in and managed research and development programs ranging over a spectrum of the basic and applied engineering sciences. Some example research activities were: radar discrimination of ICBM reentry vehicles, plasma physics and radar scattering from ICBM ionized wakes, infrared and optical ICBM signatures, infrared observational equipment development, high energy laser research, laser radar development and laser spectroscopy.

1963-1968
Assistant Professor of Electrical Engineering, MIT and Staff Member in the Research Laboratory for Electronics. Conducted research in plasma physics and electromagnetic scattering from plasmas. Led a small research group in the study of collective plasma phenomena.

Mrs. Bouquard. Thank you very much for your very excellent testimony. We look forward to you being before this committee in the future.

I wish that more members could have been with us today to hear your testimony.

Dr. Kerrebrock, NASA has the responsibility for defining and developing the civil missions for which the SP-100 technology may be applicable. What efforts are underway for us to accomplish that?

Dr. Kerrebrock. A major element of the program that we have planned cooperatively with DOE and DARPA for the next 2 or 3 years is the definition of requirements, and from our viewpoint that would be for orbital or planetary applications.

I mentioned some potential requirements before. For example, a rendezvous with the rings of Saturn or any other attractive or aggressive planetary program which goes far from the Sun could require a higher power level then the RTGs can provide. Some of those require nuclear electric propulsion systems just as the Saturn rings' rendezvous does. In this case we would need this nuclear power source to provide electricity for the main propulsion system. It would also supply electric power for communications and other needs on the spacecraft. There is a possibility that a nuclear electric power source could turn out to be the most attractive for an advanced space station, although at the present time I don't believe we would regard it as the baseline for that application.

Mrs. Bouquard. Thank you very much.

Dr. Cooper, since DARPA is to provide—to be the program manager under the terms of the agreement, how do you view the role of program director? What do you think the responsibilities of the program director entail?

Dr. COOPER. I think basically the program director function that has been spelled out in the memorandum of agreement, among the three participants in the program, is typical of the classical NASA-DOE-DARPA program manager. That is to define the scope—the technical scope—of the program; to characterize that in some kind of written documentation; to represent that program to the management, and in this case it will be the tripartite management represented by the representative of the three agencies on the Steering Committee, and then to assure that that program is defended and protected in the bureaucratic environment of Washington, and to assure that it is executed through an appropriate project office, located in this case at the Jet Propulsion Laboratory. Basically, it's that interface between the senior management in the agencies and the bureaucratic environment and the interface with the project execution—the technical project execution organization.

Mrs. BOUQUARD. How soon can we expect to see a detailed SP-100 management plan?

Dr. COOPER. Well, there was a meeting just this last Friday in which an initial draft of that management plan was put together. A great deal of progress was made on that. I believe there is another meeting to make that plan final within the coming week, and I would expect that on March 15 that plan would be put in front of the steering committee for tentative approval. It should be very soon—within 2 weeks.

Mrs. BOUQUARD. Thank you very much. Thank you gentlemen for appearing before us today. We look forward to hearing from you later in the year in this program. Now we will receive testimony from our next panel. The committee welcomes Dr. Rea, assistant laboratory director for technology and space program development, Jet Propulsion Laboratory, and Mr. John Hanson, program manager for space and military reactor development from the Los Alamos National Laboratory.

Dr. Rea, we have your complete statement. You may proceed as you wish or you may summarize, but your complete statement will be made a part of the record.

STATEMENT OF DONALD G. REA, ASSISTANT LABORATORY DIRECTOR FOR TECHNOLOGY AND SPACE PROGRAM DEVELOPMENT, JET PROPULSION LABORATORY [JPL], CALIFORNIA INSTITUTE OF TECHNOLOGY

Dr. REA. Thank you, Madam Chairman, I appreciate the opportunity to submit my statement for the record and I would like to summarize if I may.

Mrs. BOUQUARD. Please proceed.

Dr. REA. The JPL's role in space nuclear power, is presently the management of the SP-100 project, reporting to the Joint Program Office established by the DOD-DOE-NASA Memorandum of Agreement now. Most of our work is for NASA. However, over the years we have been conducting a significant amount of research and technolocy for both DOE and DOD and we are very pleased to be managing this project for the three agencies. This assignment stems from a long history of space mission and system definition and implementation programs at JPL as well as two decades of research and technology development in thermal-to-electric energy conversion for space nuclear power systems and other applications. That has culminated in the flight of Voyager. May I have the first Vu-Graph figure 1, please. Everything can be seen but the RTG's. The RTG's are the three at the bottom there. They are powering the two spacecraft. Both spacecraft have now gone past Jupiter and Saturn, and are performing well. Voyager-I is now exiting the solar system, Voyager-II is on the way to Uranus where it will arrive in 1986. We are quite optimistic that it will get to Neptune for a flyby date of 1989. I am happy to say that the power systems are working very nicely on those two spacecraft. That is the first mission that we have flown using RTG's. Galileo will use RTG's as well as the international solar polar mission for which JPL has U.S. and NASA responsibility. We now have a fair amount of flight experience in the RTG's in addition to having the R&D background in the thermoelectric conversion, and in the flight missions themselves.

FIGURE 1

Can we have the lights, please.

Mrs. BOUQUARD. Dr. Rea, we'll also want these charts for part of the record.

Dr. REA. Fine.

Mrs. BOUQUARD. Thank you.

Dr. REA. In the last few years, we have combined with the Los Alamos National Laboratory to do a specific conceptual design on a mission using a space nuclear reactor, and that resulted in a configuration that was shown before by Mr. Chipman. This is the project organization chart [figure 2] on which I will make two or three points. First of all, we have two Deputies. One is for nuclear technology, which is a DOE appointment. One of his major responsibilities will be safety. You will notice that safety is in two boxes labeled "Safety Advisory Committee" and "Safety". In the latter one we will have an overall plan developed, plus a nuclear safety plan. One of the primary responsibilities of the Deputy Project Manager for Nuclear Technology is for that total activity. Safety is one of the highest priority activities here, as we do not want to cause a hazard to personnel or to the environment.

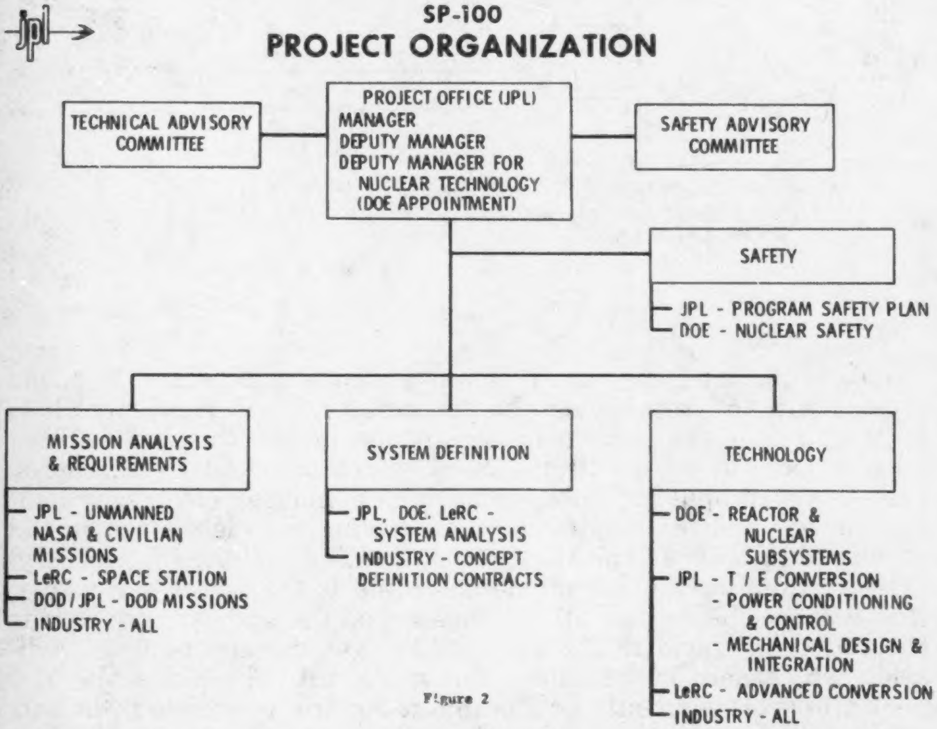

SP-100
PROJECT ORGANIZATION
TECHNICAL ADVISORY COMMITTEE
PROJECT OFFICE (JPL)
MANAGER
DEPUTY MANAGER
DEPUTY MANAGER FOR NUCLEAR TECHNOLOGY (DOE APPOINTMENT)
SAFETY ADVISORY COMMITTEE
SAFETY
JPL - PROGRAM SAFETY PLAN
DOE - NUCLEAR SAFETY
MISSION ANALYSIS & REQUIREMENTS
JPL - UNMANNED NASA & CIVILIAN MISSIONS
LeRC - SPACE STATION
DOD/JPL - DOD MISSIONS
INDUSTRY - ALL
SYSTEM DEFINITION
JPL, DOE. LeRC - SYSTEM ANALYSIS
INDUSTRY - CONCEPT DEFINITION CONTRACTS
TECHNOLOGY
DOE - REACTOR & NUCLEAR SUBSYSTEMS
JPL - T / E CONVERSION
- POWER CONDITIONING & CONTROL
- MECHANICAL DESIGN & INTEGRATION
LeRC - ADVANCED CONVERSION
INDUSTRY - ALL

Figure 2

Now, to talk about the bottom three: Mission analysis and requirements, system definition and technology—I would like to use a schematic of the SP-100 conceptual design, which was worked on by JPL and Los Alamos. Now, may I have the next slide, please [Fig. 3].

SPACECRAFT WITH NUCLEAR REACTOR POWER SUBSYSTEM

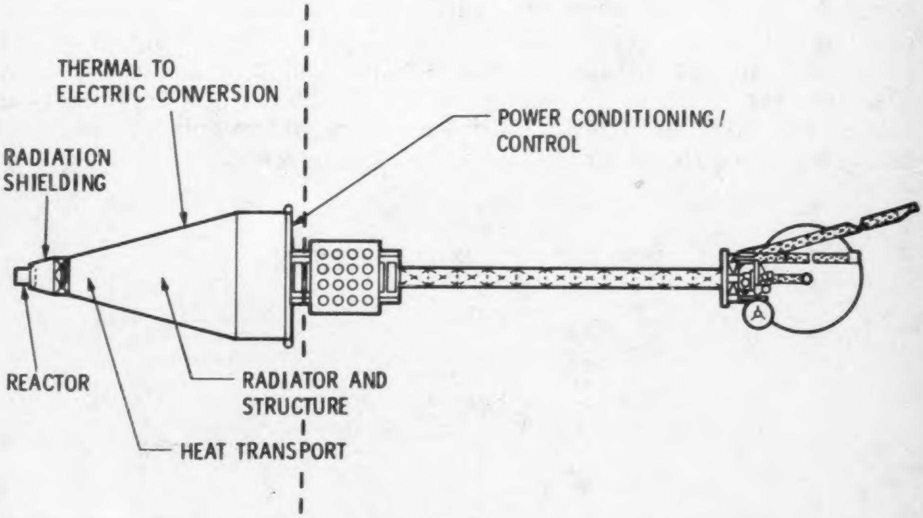

THERMAL TO ELECTRIC CONVERSION
RADIATION SHIELDING
POWER CONDITIONING / CONTROL
A
REACTOR
RADIATOR AND STRUCTURE
HEAT TRANSPORT

Figure 3

This is the total spacecraft. It was aimed at a potential Neptune orbiter with a probe using the spacecraft on the right, which is very similar to the Galileo spacecraft and probe. This is connected with a boom to the 16 circles there, which are actually thrusters. This is the propulsion subsystem—it is a nuclear electric propulsion device, and the major reason for having the high power in the reactor is in order to run those thrusters. The fuel used is mercury.

Everything on the left of the dash line is the power subsystem. You will see the reactor all the way out on the end. Next to that is the radiation shield to cut down on the gamma and neutron radiation which can be seen near the spacecraft. There are also the heat transport elements or thermal-to-electric conversion—in this case it is thermoelectrics, which is similar to the ones we are flying in the RTG's, radiator, structure, and finally the power conditioning and control to provide the interface between the power generated by the thermoelectric elements and the rest of the spacecraft.

SP-100 PROJECT

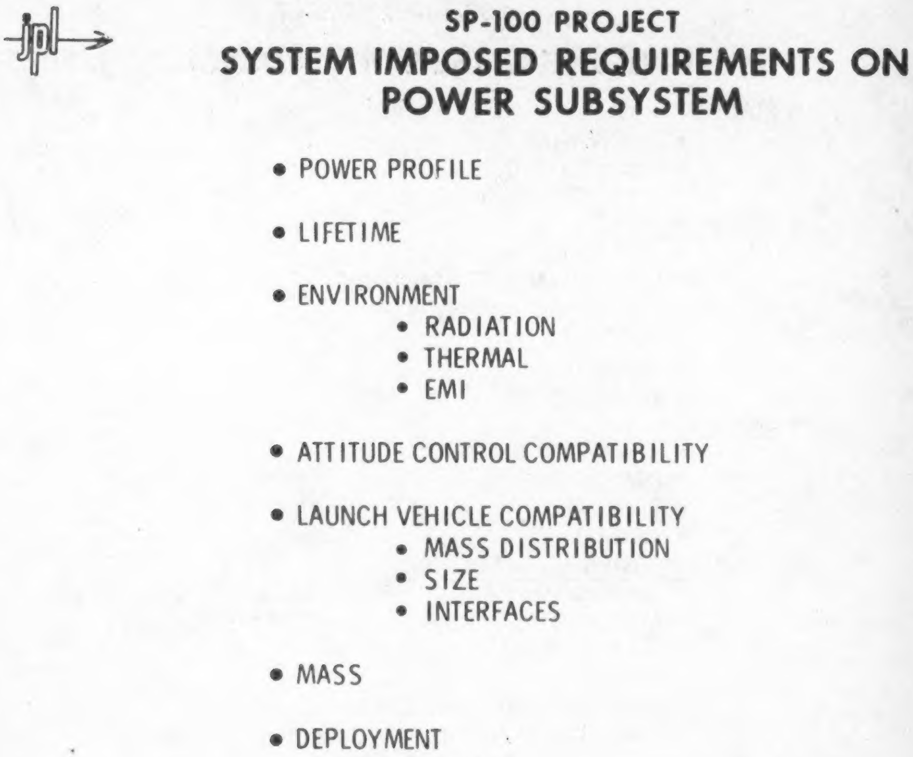
NUCLEAR REACTOR POWER TECHNICAL ISSUES

- REACTOR
    - TEMPERATURE
    - FUEL SWELLING
    - REACTOR CONTROL
- HEAT TRANSPORT
    - HEAT PIPE STARTUP
    - PUMP RELIABILITY/LONGEVITY
- THERMAL TO ELECTRIC CONVERSION
    - EFFICIENCY
    - LONGEVITY
    - RADIATION EFFECTS
- RADIATOR
    - STRUCTURAL DESIGN
    - TEMPERATURE
    - SIZE, MASS
    - MATERIAL
- POWER CONDITIONING AND CONTROL
    - TEMPERATURE & RADIATION EFFECTS ON COMPONENTS
    - AVAILABILITY OF HIGH POWER FLIGHT COMPONENTS
    - VOLTAGE/CURRENT TRADE-OFFS
- ATTITUDE CONTROL
    - BOOM OR TETHER CONNECTION
    - STABILITY, ESPECIALLY WITH DYNAMIC SYSTEMS
    - RADIATION EFFECTS

Figure 4

Now, next I would like to address the technical issues—next Vugraph, please [Fig. 4].

This is actually a subset of the technical issues which have been identified. I will not dwell on them. I'm putting this up to give you a feeling for the complexity of the technology challenge that we are facing. Essentially, every element of the power subsystem has major questions associated with the technology. The basic thrust of what we will be doing for the next 3 years is to tackle these areas, get a handle on them, and hopefully resolve them so that in 3 years time we will be confident of the technology, so we can develop a system design that we can rely on, or at least one so that we can test further the evolution of that flight system design.



SP-100 PROJECT

SYSTEM IMPOSED REQUIREMENTS ON POWER SUBSYSTEM

- POWER PROFILE
- LIFETIME
- ENVIRONMENT
  - RADIATION
  - THERMAL
  - EMI
- ATTITUDE CONTROL COMPATIBILITY
- LAUNCH VEHICLE COMPATIBILITY
  - MASS DISTRIBUTION
  - SIZE
  - INTERFACES
- MASS
- DEPLOYMENT

Figure 5

The next VuGraph [Fig. 5] discusses the mission-related system requirements. There are technology issues identified with the power subsystem per se, but then there are also requirements imposed on that power system from outside that I would like to treat a little differently. In the environment, the radiation is a matter of major concern, and the SP-100 conceptual design which I showed a few minutes ago has a radiation level at the spacecraft—that is on the right-hand side where all the sensors are—is an order of magnitude or more too high. In other words, we are getting too much gamma radiation, too much neutron flux for the electronics and, unfortunately, our electronics are going in a direction of miniaturization which increases their sensitivity. So, we have a significant problem to resolve there in order to bring the radiation level down in some manner to a level which we can handle by the electronics that we want to fly. The rest of the mission related system requirements are fairly obvious.

The mission applications study will cover both the civilian and the military sectors. Studies of unmanned civilian missions will be corrdinated by JPL and the Lewis Research Center. I agree with Dr. Kerrebrock that nuclear reactors have a major potential for future power subsystems for space station. DOD will evaluate its own future needs and input them to the project.

Before completing this testimony, I would like to emphasize the role that industry will play in this activity. We have now let three contracts for major system studies—conceptual system studies—by industry. These will be followed up by a subset of these contractors doing further system studies, plus technology studies focused on their particular needs.

Industry has a great wealth of experience and there is a lot of background there we want to capitalize on. With this industrial involvement and the active participation at Lewis, other NASA centers, and the DOE Laboratories, we are, in fact, harnessing the capabilities of the nation to develop expeditiously this important capability for spacemissions.

I would like to thank you, Madam Chairman, for the opportunity to speak here today. I will, of course, be happy to answer any questions.

[The prepared statement of Dr. Rea follows:]

HOLD FOR RELEASE
UNTIL PRESENTED
BY WITNESS
MARCH 8, 1983

Statement of

Dr. Donald G. Rea
Assistant Laboratory Director
for Technology and Space Program Development
Jet Propulsion Laboratory
California Institute of Technology

before the

Subcommittee on Energy Research and Production
Committee on Science and Technology
House of Representatives

Madam Chairman and Members of the Subcommittee:

It is a pleasure to accept your invitation to discuss with you the role of the Jet Propulsion Laboratory in Space Nuclear Power.

The Jet Propulsion Laboratory's role in Space Nuclear Power presently is the management of the SP-100 Project, reporting to the Joint Program Office established on February 11 in the DOD/DOE/NASA Memorandum of Agreement. While the majority of the Laboratory's work is for NASA, we do conduct a significant amount of Research and Technology for both DOE and DOD and we are very pleased to be managing this project for the three agencies. This assignment stems from a long history of space mission and system definition and implementation programs at JPL as well as two decades of research and technology development in thermal-to-electric energy conversion for space nuclear power systems and other applications. Our nuclear power flight experience is with Radioisotope Thermoelectric Generators (RTGs), which are powering JPL's Voyager spacecraft and which will be used on Galileo.

Our thermoelectric energy conversion research and technology work for NASA, funded at a level of about $1.5 million per year, is directed toward space nuclear power applications. In conjunction with planetary mission studies at JPL and nuclear system activities at Los Alamos National Laboratory, this work has led to the SP-100 design concept definition which was documented by JPL and Los Alamos last year. In addition to industry contracts for improved materials research, JPL conducts extensive experimentation in a dedicated facility housing unique instrumentation specifically designed for this work. This work together with our extensive experience in developing spaceflight projects has led to the current assignment of the SP-100 Project to JPL.

To implement the Project, we have established a Project Office at JPL reporting directly to my office. It is staffed with highly qualified professionals with extensive experience in R & D management. They are supported by the appropriate JPL technical divisions and by contractors. The Project management will include a Deputy Manager for Nuclear Technology who will be appointed by DOE. The Project will manage the SP-100 work at DOE Laboratories, NASA Centers, and Contractor facilities.

Safety is being given the highest priority in the SP-100 Project. Comprehensive plans covering all aspects of space nuclear power from development to deployment and disposal are being implemented. These plans will ensure that no hazard is presented to the population or the environment.

The technologies required for a meaningful system in the 100-kW class are not presently available, but we believe they can be derived by advancing existing technologies. Nuclear technologies are the purview of the Department of Energy; I understand that these technologies will be addressed by DOE and Los Alamos National Laboratory representatives in their testimony. Thermal-to-electric conversion technologies exist but are not presently suitable for a 100-kW-class system. For example, present thermoelectric couples are an order of magnitude too heavy for these applications, and present silicon-germanium materials for these couples operate at inappropriately low temperatures and below the desired performance. Other technology areas have similar deficiencies and require significant development before they can be considered for incorporation in a flight nuclear reactor power subsystem.

An important early objective of the SP-100 Project is to develop a set of mission related system requirements. The mission applications will cover both the civilian and the military sectors. Studies of unmanned and manned civilian missions will be coordinated by JPL and the Lewis Research Center, respectively. The Department of Defense will evaluate its future needs and input them to the Project. Specific mission examples for the potential application of space nuclear reactor power subsystems are given in the testimony of Dr. Cooper and Dr. Kerrebrock.

Another major activity of the Project will be industry studies of design concepts and of the associated technologies. We wish to capitalize on the wealth of experience available in industry to generate innovative design concepts and to develop aggressively the necessary technology. With this involvement and the active participation of the Lewis Research Center, other NASA centers and of the DOE Laboratories a broad spectrum of the nation's capabilities will be harnessed to develop expeditiously this very important capability for space missions.

In conclusion, Madam Chairman, I wish to thank you and the Subcommittee for the opportunity to talk to you today.

DR. DONALD G. REA
ASSISTANT LABORATORY DIRECTOR
OFFICE OF TECHNOLOGY AND SPACE PROGRAM DEVELOPMENT

Dr. Donald G. Rea has been Assistant Laboratory Director, Office of Technology and Space Program Development, at the Jet Propulsion Laboratory since 1980.

Doctor Rea earned his Bachelor of Science in chemistry at the University of Manitoba in 1950; his Master's in physical chemistry from the University of Manitoba in 1952, and the PhD in physical chemistry from the Massachusetts Institute of Technology in 1954.

From 1955 to 1961 Doctor Rea worked for the California Research Corp., doing infrared spectroscopy of absorbed species. In 1961 he joined the Space Sciences Laboratory at the University of California, Berkeley, where he did spectroscopic studies of planets.

From 1968 to 1970, Doctor Rea was deputy director of the planetary program at NASA Headquarters, Washington, D.C.

He joined the Jet Propulsion Laboratory, California Institute of Technology, in 1970 as Assistant Laboratory Director for Science, and assumed his present position in 1980.

Doctor Rea served as a Postdoctoral Research Fellow at Cambridge University from 1954 to 1955, and as a Research Fellow, J.F. Kennedy School of Government at Harvard University, from 1979 to 1980.

He received the NASA Exceptional Scientific Achievement Medal in October 1969. He received an honorary Doctor of Science degree from the University of Manitoba in 1980.

Doctor Rea is married and has two children. He and his family live in Pasadena, Calif.

Mrs. **Bouquard**. Thank you very much for being with us, and for your fine testimony.

Mr. Hanson, we look forward to hearing from you next.

STATEMENT OF JOHN E. HANSON, PROGRAM MANAGER FOR SPACE AND MILITARY REACTOR PROGRAMS, LOS ALAMOS NATIONAL LABORATORY

Mr. **Hanson**. Madam Chairman, it is a pleasure to appear before you today to discuss the Department of Energy-sponsored Space Nuclear Reactor and Heat Transport Research and Development Activities at the Los Alamos National Laboratory. Because I have only recently joined the Laboratory, I am accompanied by Mr. Jim Scott, a senior member of the Laboratory management staff. At this time I'd like to introduce Mr. Scott.

Mrs. **Bouquard**. Mr. Scott, we're glad to have you with us today.

Mr. **Hanson**. In this presentation, I shall summarize the description of the heat pipe reactor concept, the supporting research and development activities and their status, and briefly discuss future-year funding requirements, as you requested. More detailed information on the research and development activities are presented in the written statement.

Mrs. **Bouquard**. Your written statement will be made a part of the record.

At this time I would like to ask all the witnesses if they would respond to written questions, from the members that could not be here today, that will be made part of the record.

Mr. **Hanson**. Of course.

The Laboratory's space nuclear reactor research and development activities are focused on a concept known as the heat pipe reactor, which has already been mentioned. Its most salient characteristics are that the heat generation, heat transport and electrical generation subsystems have no moving parts, thus providing the potential for a highly reliable, compact, relatively low weight system. Additionally, the absence of a pressure vessel facilitates burnup on reentry; a significant safety feature. Heat is generated by fast neutron-induced fissioning of uranium 235. The heat is transferred into heat pipes which contain the liquid metal, lithium. The lithium is vaporized and flows to the electric converter end of the heat pipe, where it is condensed to liquid and flows by differential pressure through a wick back to the core end of the pipe. Electricity is generated by thermoelectric elements which surround that portion of the heat pipe between the reactor and radiator. The fuel module in this reactor concept is quite different from that with which you may be familiar. It is composed of uranium dioxide tiles which surround the heat pipe so that, with respect to conventional nuclear powerplant fuel, it is inside out.

The key technology areas attendant with this reactor concept are: high temperature liquid metal heat pipe research and development, and fuel module behavior characteristics.

Areas being addressed in the present program which are somewhat more generic in nature—that is, they apply to many of the reactor concepts being proposed for space power applications—are:

refractory metal alloy development, and nuclear and radiological safety.

I should now like to summarize the status of the various tasks being pursued in the present program, and again a more detailed discussion of these activities is included in the written statement.

In the area of core design, as has been mentioned, a conceptual design of 100-kilowatt heat pipe reactors has been generated, principally to guide the technology development activities. The refinements which have been incorporated over the past 4 years are typical of the early stages of a project of modest effort, such as this, and we can anticipate further refinements as additional analyses are completed and data are obtained from the heat pipe and fuels and materials research tasks.

In the area of heat pipe development the fundamental principles of heat pipe operation are well understood and heat pipes are used in a wide range of industrial applications. A recent study by the Thermacore Co. confirmed our view that the adaptation of the heat pipe to the heat pipe reactor concept is technically feasible, but further development for this high temperature application is required. Such work is being pursued. Most recently we have successfully completed a 100-hour test of a 2-meter-long, lithium-filled heat pipe at temperatures up to 1,500 Kelvin and heat input of 15 kilowatts. These parameters are representative to calculated operating conditions for the heat pipe reactor. Further heat pipe research underway addresses effects on heat pipe performance of wick configuration, long-term high temperature effects such as corrosion, erosion, and diffusion, and the development of coatings which increase the ability of the pipes to transfer heat by radiation in space.

In the area of materials development the very high working temperatures required for nuclear space reactors capable of providing relatively large amounts of electricity necessitate the use of refractory metal alloys for structural and heat transport systems. We have selected molybdenum, 13 percent rhenium alloy as a material which may embody the requisite thermomechanical properties. Procurement of this material has been extremely difficult because there is virtually no industrial capability to supply refractory alloys in seamless tubing form. The Oak Ridge National Laboratory has ably assisted us in this effort and, because of their unique refractory metals expertise and fabrication facilities, will of course, continue to play a major role in this area.

With respect to irradiation testing, an experiment embodying many of the features of the heat pipe reactor fuel module has been designed for irradiation in the Experimental Breeder Reactor-2 at the Idaho National Engineering Laboratory. Fabrication and assembly of the capsule has been temporarily interrupted due to the development of a pin hole leak in the heat pipe. We are presently investigating the cause of the defect.

With respect to safety analyses and testing we have prepared a draft SP-100 program safety plan that has been reviewed by DOE. Revisions to the draft based on comments from the DOE reviewers are in progress. The purpose of the plan is to define the safety requirements and integrate them into the overall SP-100 program plan to assure that safety analyses and tests are performed in a logical progression as the program proceeds.

Because of the limited funding in the program, there is presently no ongoing effort in controls and instrumentation.

With respect to reactor test facilities, there is general recognition that large-scale reactor test facilities will be required if the program goes into the ground engineering phase. However, the present limited resources have precluded development of firm estimates and schedules for refurbishment of existing facilities.

Finally, I'd like to mention that we have a number of subcontractors engaged in special studies or providing technical support. I've already mentioned Thermacore and Oak Ridge National Laboratory. The others are Westinghouse Advanced Reactors Division, Thermo Electron Corp. in Massachusetts, General Electric Co's Advanced Reactor Systems Department, Battelle Columbus Laboratories and Battelle Pacific Northwest Laboratory, and the Hanford Engineering Development Laboratory.

With regard to future-year funding requirements, the only information I have at this time is that the guidance we have from DOE is for a funding level of $2.2 million in fiscal year 1984. This follows a funding history of approximately $2 million per year since fiscal year 1979. As you've heard, the programs are being combined and I await further instructions from the steering committee and the program and project offices in that regard.

This concludes my oral presentation.

[The prepared statement of Mr. Hanson follows:]

Prepared Statement of John E. Hanson, Program Manager, Space and Military Reactor Programs, Los Alamos National Laboratory

Madam Chairman and Members of the Subcommittee, it is a pleasure to appear before you today to discuss the Department of Energy sponsored Space Nuclear Reactor and Heat Transport Research and Development Activities at the Los Alamos National Laboratory. Because I have only recently joined the Laboratory, I am accompanied by Mr. Jim Scott, a senior member of the Laboratory management staff. At this time I'd like to introduce Mr. Scott.

In this presentation I shall summarize the description of the heat pipe reactor concept, the supporting research and development activities and their status, and briefly discuss future-year funding requirements. More detailed information on the research and development activities are presented in the written statement.

The Laboratory's space nuclear reactor research and development activities are focused on a concept known as the Heat Pipe Reactor. I shall only summarize its most salient characteristics here as the written statement includes a report on the conceptual design description. The most unique feature of the reactor concept is that the heat generation, heat transport and electrical generation subsystems have no moving parts, thus providing the potential for a highly reliable, compact, relatively low weight system. Additionally, the absence of a pressure vessel facilitates burnup on reentry; a significant safety feature. Heat is generated by fast neutron-induced fissioning of ^{235}U. The heat is transferred into heat pipes which contain the liquid metal, lithium.

The lithium is vaporized and flows to the electric converter end of the heat pipe, where it is condensed to liquid and flows by differential pressure through a wick back to the core end of the pipe. Electricity is generated by thermoelectric elements which surround that portion of the heat pipe between the reactor and radiator. The fuel module in this reactor concept is quite different from that with which you may be familiar. It is composed of uranium dioxide tiles which surround the heat pipe so that, with respect to conventional nuclear power plant fuel, it is inside out.

The key technology areas attendant with this reactor concept are: high temperature liquid metal heat pipe research and development, and fuel module behavior characteristics.

Areas being addressed in the present program which are somewhat more generic in nature are: refractory metal alloy development, and nuclear and radiological safety.

I should now like to summarize the status of the various tasks being pursued in the present program. A more detailed discussion of these activities is included in the written statement.

Core Design - A conceptual design of a 100 KW_e heat pipe reactor has been generated to guide the technology development activities. Refinements have been incorporated over the past four years. As is typical in the early stages of a project of modest effort such as this, further refinements can be anticipated as additional analyses are completed and data are obtained from the heat pipe and fuels and materials research tasks.

Heat Pipe Developments - The fundamental principles of heat pipe operation are well understood and heat pipes are used in a wide range of industrial applications. A recent study by the Thermacore Company in Lancaster, Pennsylvania, confirms our view that adaptation of the heat pipe to the Heat Pipe Reactor concept is technically feasible, but further development for this high temperature application is required. Such work is being pursued. Most recently we have successfully completed a 100-hour test of a 2-m-long, lithium-filled heat pipe at temperatures up to 1500 K (2241 F) and heat input of 15 kW. These parameters are representative of calculated operating conditions for the Heat Pipe Reactor. Further heat pipe research underway addresses effects on heat pipe performance of wick configuration, long-term high temperature effects such as corrosion, erosion and diffusion, and the development of coatings which increase the ability of the pipes to transfer heat by radiation.

Materials Development - The very high working temperatures required for nuclear space reactors capable of providing relatively large amounts of electricity necessitate the use of refractory metal alloys for structural and heat transport systems. We have selected molybdenum, 13 percent rhenium alloy as a material which may embody the requisite thermo-mechanical properties. Procurement of this material has been extremely difficult because there is virtually no industrial capability to supply refractory alloys in seamless tubing form. The Oak Ridge National Laboratory has ably assisted us in this effort and, because of their unique refractory metals expertise and fabrication facilities, will continue to play a major role in this area.

Irradiation Testing - An experiment embodying many of the features of the heat pipe reactor fuel module has been designed for irradiation in the Experimental Breeder Reactor-2 (EBR-2) at the Idaho National Engineering Laboratory. Fabrication and assembly of the capsule has been interrupted due to the development of a pin hole leak in the heat pipe. We are presently investigating the cause of the defect.

Safety Analyses and Testing - We have prepared a draft SP-100 Program Safety Plan that has been reviewed by DOE. Revisions to the draft based on comments from the DOE reviewers are in progress. The purpose of the plan is to define the safety requirements and integrate them into the overall SP-100 Program Plan to assure that safety analyses and tests are performed in a logical progression as the program proceeds.

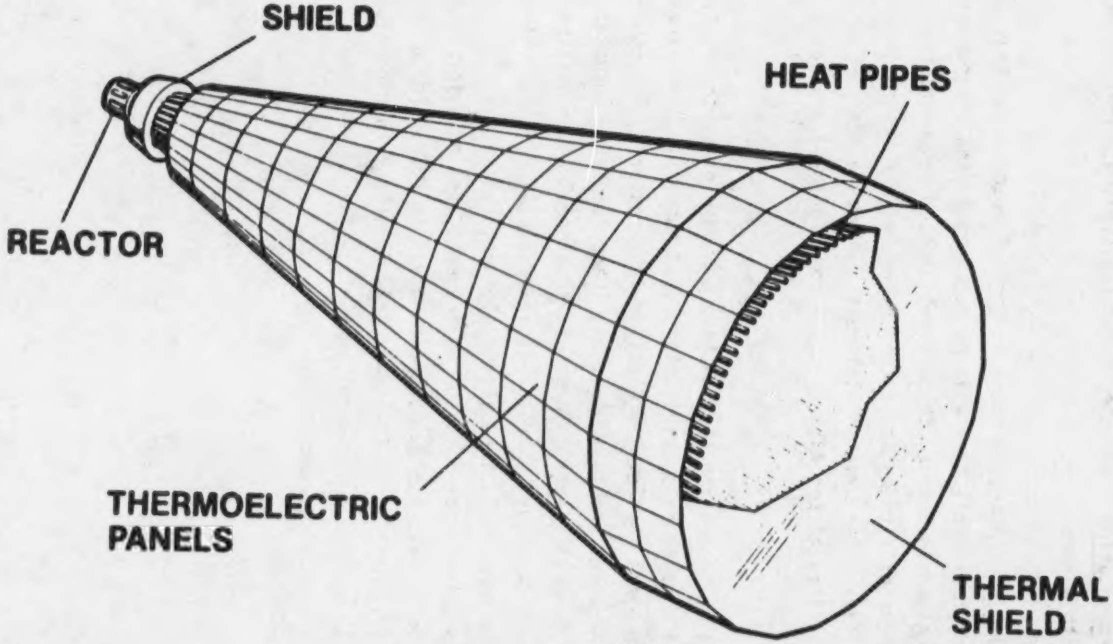
Controls and Instrumentation - Because of limited funding, there is no ongoing effort in this area.

Reactor Test Facilities - Although there is general recognition that large-scale reactor test facilities will be required if the program goes into the ground engineering phase, the present limited resources have precluded development of firm estimates and schedules for refurbishment of existing facilities. The written statement includes a description of the UHTREX Test Facility at Los Alamos, which could be made available if desired.

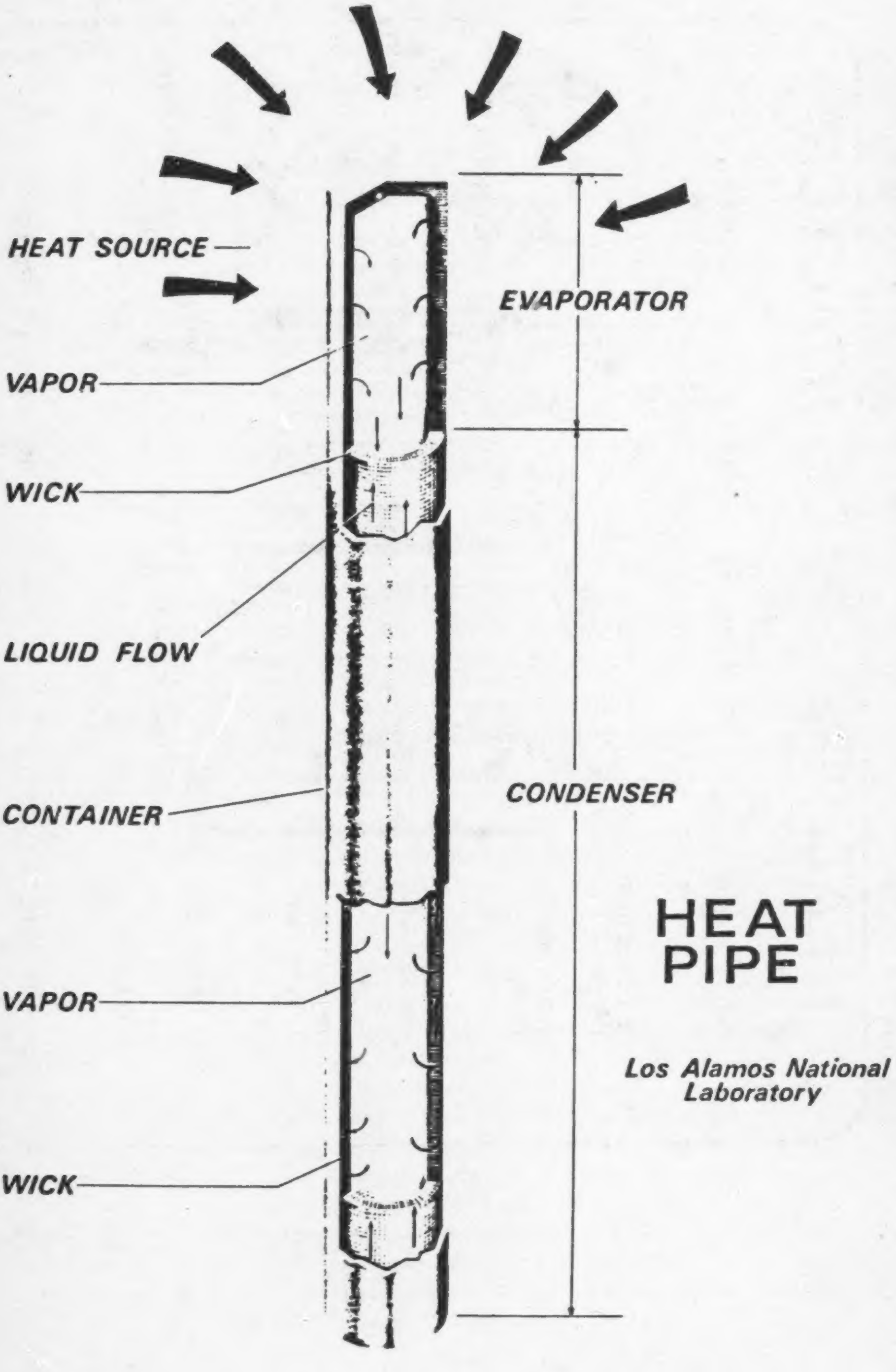
Finally, I'd like to mention that we have a number of subcontractors engaged in special studies or providing technical support. I've already mentioned Thermacore and the Oak Ridge National Laboratory. The others are Westinghouse Advanced Reactors Division, Thermo Electron Corporation in Massachusetts, General Electric Company's Advanced Reactor Systems Department, Battelle Columbus Laboratories and Battelle Pacific Northwest Laboratory, and the Hanford Engineering Development Laboratory.

With regard to future-year funding requirements, the only information I have at this time is that the guidance we have from DOE is for a funding level of $2.2 million in FY-1984. This follows a funding history of approximately $2 million dollars per year since fiscal year 1979.

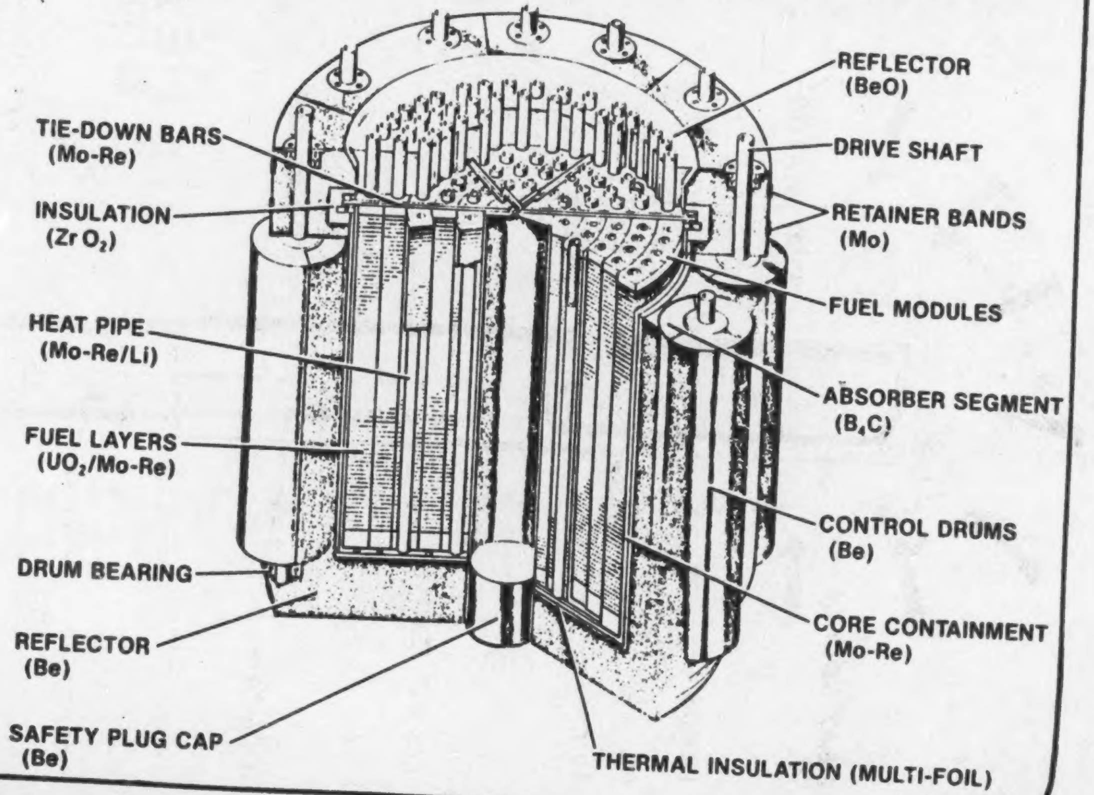
This concludes my oral presentation.

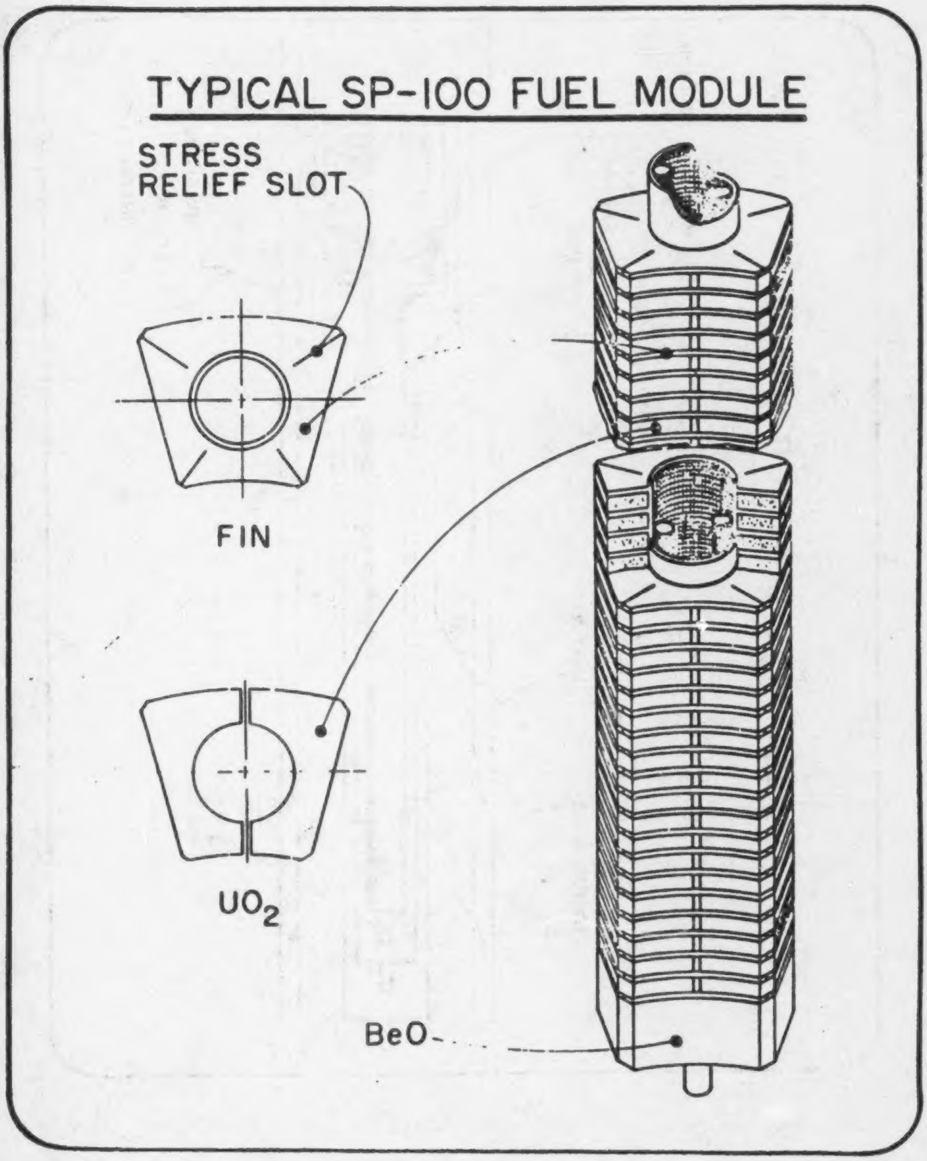

SHIELD
HEAT PIPES
REACTOR
THERMOELECTRIC PANELS
THERMAL SHIELD

SP-100 NUCLEAR POWER SYSTEM
RADIATIVELY COUPLED SYSTEM DESIGN

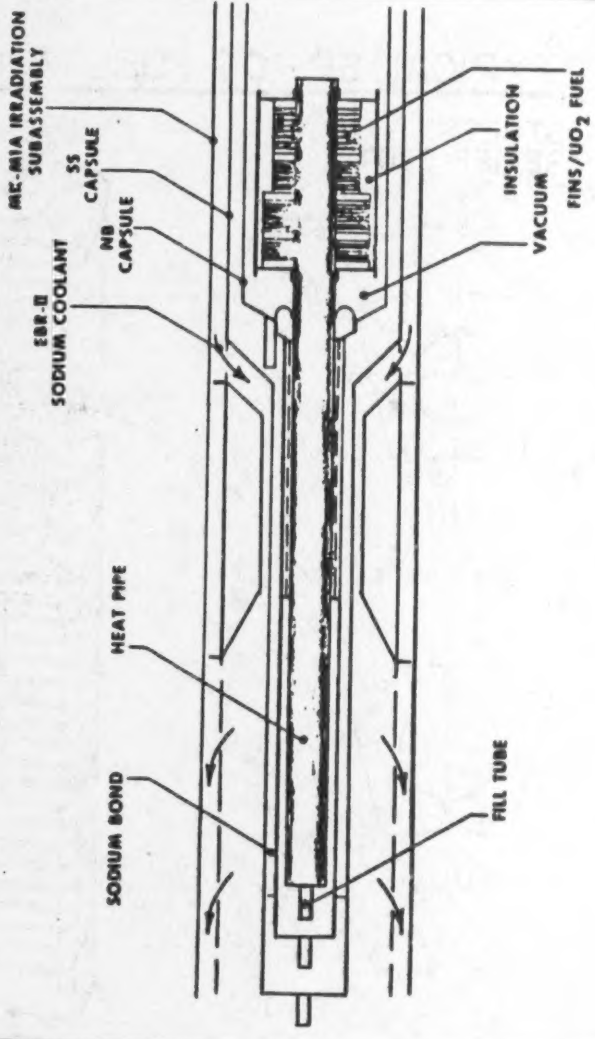

HEAT SOURCE
VAPOR
WICK
LIQUID FLOW
CONTAINER
VAPOR
WICK
EVAPORATOR
CONDENSER
HEAT
PIPE
Los Alamos National
Laboratory

HEAT PIPE SPACE REACTOR


TIE-DOWN BARS (Mo-Re)
INSULATION (ZrO_2)
HEAT PIPE (Mo-Re/Li)
FUEL LAYERS (UO_2/Mo-Re)
DRUM BEARING
REFLECTOR (Be)
SAFETY PLUG CAP (Be)
REFLECTOR (BeO)
DRIVE SHAFT
RETAINER BANDS (Mo)
FUEL MODULES
ABSORBER SEGMENT (B_4C)
CONTROL DRUMS (Be)
CORE CONTAINMENT (Mo-Re)
THERMAL INSULATION (MULTI-FOIL)


TYPICAL SP-100 FUEL MODULE
STRESS RELIEF SLOT
FIN
UO2
BeO

SP-100 FUEL EXPERIMENT IN EBR-II


ME-MIA IRRADIATION SUBASSEMBLY
SS CAPSULE
NB CAPSULE
EBR-II SODIUM COOLANT
HEAT PIPE
SODIUM BOND
FILL TUBE
VACUUM
INSULATION
FINS/UO$_2$ FUEL

BIOGRAPHICAL SKETCH

John E. Hanson is the Program Manager for Space and Military Reactor Programs at the Los Alamos National Laboratory. He is responsible for development, planning, and implementation of space and military reactor programs at the Laboratory.

He joined the Laboratory in January 1983 after serving three years with EG&G Idaho as Principal Engineer. In that time he was involved in the formulation of the TMI-2 core examination program and the NRC Severe Fuel Damage Program. He also participated in the new production reactor concept evaluation, Clinch River Breeder Reactor licensing and served on a DOE Fact Finding Group for Public Law 96-567.

From 1966 to 1979 while with the Westinghouse Hanford Company, Hanson managed the Fast Flux Test Facility fuel development and safety research programs; programs of major national scope.

From 1956 to 1966 he was employed by the General Electric Company's Hanford Atomic Products Operation in Richland, Washington; the Vallecitos Nuclear Laboratory in Pleasanton, California; and the Advanced Reactors Division in San Jose, California.

Hanson has a MS degree in mechanical engineering and holds professional engineer licenses in mechanical and nuclear engineering.

Mrs. BOUQUARD. Thank you very much, Mr. Hanson. Before we continue with questions I would like to recognize a very distinquished group of Tennesseans with us today from the Third District of Tennessee, representing the VFW. We're happy to have you gentlemen with us today as well. Thank you for being with us.

Very interesting testimony, Dr. Rea and Mr. Hanson.

What are the critical issues that you see that remain before we can proceed with and build the development prototype of the heat pipe reactor? What are the issues that you see that we have before us?

Mr. HANSON. The most pressing issue at this time is the development of the high-temperature refractory alloys. As I indicated in my testimony, we are having some difficulty in the procurement and we're looking to the Oak Ridge National Laboratory to help us with that.

The effort following all of that is the actual long-term testing of heat pipe systems. To look at such things as corrosion, erosion and diffusion, which are temperature dependent and also time dependent phenomena.

Mrs. BOUQUARD. Do you think there are real safety advantages in the heat pipe reactor?

Mr. HANSON. I am told that the heat pipe reactor offers some safety advantages in the sense that it is compact plus the outstanding one, of course, which is that it does not have a pressure vessel, which would preclude or inhibit the burnup on reentry.

Mrs. BOUQUARD. But you do think that all the critical issues can be resolved within the timeframe as specified in the memorandum agreement? Mr. Hanson.

Mr. HANSON. I believe that we—with the appropriate definition of, and again I wait the combination of the two programs to learn more precisely what the technology objectives may be at the end of fiscal year 1985—I believe that we should be able to make well informed judgments on technical feasibility for continuation of the project at that time.

Mrs. BOUQUARD. You mentioned your work in relationship with the laboratories in your testimony. As for these other organizations, would you enlarge on your definition of your working relationship with the laboratories and with private industry?

Dr. REA. With the laboratories it varies, of course, depending upon which ones we are discussing. In the case of the Lewis Research Center, we've had a long working relationship with them, certainly in terms of technical exchange, in the thermoelectric conversion. They are playing a key role in examining alternate forms of energy conversion other than thermoelectric. They are also playing a major role in examining megawatt systems. Now, that's a very low-level activity. The vast majority of our work is focused on the 100-kilowatt system, but we are doing a small amount of work on multimegawatt systems. We had a very successful workshop in the Laboratory on that subject last week.

Our organizational relationship with the DOE laboratories have yet to be defined.

In the case of industry, of course, interaction there is by contract; we have three major contracts that have been let. There will be small contracts for technology work, which will be let directly by the laboratory and then, of course, Los Alamos has contracts with industry, and Lewis will be having contracts with industry. Communications are always a difficult problem, and something you have to work intentionally, and when you start getting involved with other organizations it becomes more challenging.

Mrs. BOUQUARD. What kind of materials research is being done to meet the SP-100 requirements? You mentioned in your testimony that you were monitoring the industry contracts in this area.

Dr. REA. First of all, in the technology area we have defined a very low-level of activity for materials research for structures. Now, that's for the structure itself, and the concern there has to do with mass. We are currently tackling other aspects of the technology rather than that particular one. The industry studies are currently conceptual definition studies and will move into a technology phase after a year or year and a half. Then, if they have identified materials as a major problem, we're going to have to give more attention to that area. Now, Mr. Hanson referred to the materials problems associated with the molybdenum rhenium alloy in the heat pipe. Materials, actually, cut across almost all areas. So, if you will, you could address materials in any part of the total subsystem. The one I was addressing, really, was the materials part of the structure. We are not giving much attention to that area at the present time. However, we conduct considerable advanced thermoelectric materials research and development.

Mrs. BOUQUARD. Mr. Hanson, do you receive funding for your reactor work from any source other than DOE?

Mr. HANSON. Not at the present moment. I will look at the—after the programs are combined the laboratory will see funding, which I anticipate is increased. I'm not familiar with the bookkeeping process involved in the combination of the three agencies and how the laboratory funding will show up. Perhaps Mr. Scott would know.

He may not have heard me. Just a moment.

Apparently, that has to yet be worked out.

Mrs. BOUQUARD. Thank you very much. If you would supply this information for the record. Thank you gentlemen for your testimony. I appreciate all of our participants being with us this afternoon.

The Subcommittee on Energy Research and Production will hold a hearing tomorrow on the Conventional Reactor Systems. We'll be hearing from DOE and non-DOE witnesses. Our hearing is scheduled for 9:30 in the morning in room 2325. Thank you very much.

The committee is adjourned.

[Whereupon, at 3:45 p.m. the subcommittee was adjourned until Wednesday, March 8, 1983.]

APPENDIX

Los Alamos
Los Alamos National Laboratory
Los Alamos, New Mexico 87545

DAD/NP-83-387

April 25, 1983

Ms. Julie Shisler
Subcommittee on Energy, Research
and Production
Room B-374
Rayburn House Office Bldg.
Washington, DC 20515

Dear Ms. Shisler:

REF: Letter of April 7, 1983, Marilyn Lloyd Bouquard to Donald M. Kerr

This is in reply to Mrs. Bouquard's letter to Dr. Kerr requesting response to additional questions on the Space Reactor Program be sent to you on or before April 25.

Enclosed are my answers to the questions she submitted.

Yours truly,

John E Hanson

John E. Hanson
SP-100 Deputy Project Manager
for Nuclear Technology

Enc: a/s

Cy: M. L. Bouquard
J. Anbrus, NASA
S. J. Lanes, USDOE
W. E. Wright, DARPA
V. Truscello, JPL
D. M. Kerr, DIR, A100
K. D. Lathrop, ADES, A145
J. E. Boudreau, DAD/NP, F671
J. A. Sullivan, DAD/NP, F671
CRMO, A145

- Your testimony states that no funding is included for the heat pipe reactor in the controls and instrumentation area. How will this impact your program?

Answer

Prior to the February 11, 1983, DOE/NASA/DARPA Memorandum of Agreement (MOA), the heat pipe reactor development program being conducted at Los Alamos National Laboratory was a relatively low level exploratory program focused principally on establishing the technical feasibility of the reactor concept from the standpoint of fuel and heat pipe design. With the advent of the MOA and the start of the systems design work at General Electric Company, Westinghouse, and General Atomic Technologies, the controls and instrumentation area will receive the requisite attention. Thus, in short, there has not been any impact on the program.

Minority Questions

- Mr. Hanson, what experiences, training, and background do you bring to the space and military reactor programs?

Answer

The attached experience and qualification summary was submitted to the SP-100 Program Office and Steering Committee to support my nomination for the position of Deputy Project Manager for Nuclear Technology.

- What other applications for the Heat Pipe Reactor do you anticipate?

Answer

The heat pipe reactor is attractive for space applications because of its potential for high reliability and relative simplicity in addition to small size and light weight. The heat pipe technology associated with these designs could form a basis for a passive, i.e., no moving parts or electrical power requirements, heat transport system for heat removal under emergency conditions in advanced terrestrial nuclear power plants. Such heat pipe technology might also be adapted to heat removal systems required for the long-term storage of highly radioactive materials.

- What experience exists to indicate that reactors can be developed for space exploration?

Answer

US flight experience with reactor space power systems is admittedly limited. However, numerous concepts were studied in the 50s and 60s before this application was deemphasized in the domestic nuclear power development program. One such concept, SNAP-10A, was launched and operated in space. A sufficient technology base was built then and has been expanded at Los Alamos and elsewhere to permit one to say with confidence that a satisfactory system can be developed and deployed to this mission.

I am certain you are aware that the Soviet Union has employed nuclear reactors for space power applications. While the history of the Soviet systems may not be the most favorable commentary on the idea, it must be concluded that Russion technology has surmounted many of the problems we confront. I am confident that the US technological community is capable of accomplishing this purpose safely.

- What evidence is there that materials can withstand the temperatures we are discussing (1500 K - 1700 K) for periods of years?

Answer

In the late 1960s a considerable body of work was done investigating and using materials at high temperatures. This work included testing various refractory metals and their alloys under load conditions to determine how they behaved for periods on the order of a year at temperatures in excess of 1700 K. A number of heat pipe tests have been conducted for times in the range of 1 to 3 years and temperatures of 1700 to 1900 K. High-temperature fuels irradiation programs have demonstrated the basic stability of refractory metal claddings (as well as the oxide, carbide, and nitride fuel they contained) for periods in excess of a year and for temperatures ranging from 1500 to 2000 K).

In general, the behavior of a number of refractory metals and compounds for long times at high temperatures is understood sufficiently well to provide confidence that long times at the above temperatures will not lead to poor behavior.

- In addition to materials problems at elevated temperatures, what evidence exists that reactor components will endure?

Answer

Many of the space reactor components are required to move slowly or not at all and experience little, if any, load during the reactor lifetime. Hence, these components (reflector, insulation, core mounts, control drums) are not expected to be lifetime limiting. Control drum actuator motors have been tested for three years under conditions closely simulating those that will obtain in a modern space reactor. The main lifetime limiting effects in the reactor power system design are the conversion system (except the thermoelectrics, where exceedingly long lifetime capability has been demonstrated by the Pioneer and Voyager missions); potential corrosion and erosion effects in the system that transports the reactor heat to the conversion system; high-temperature pumps for some cooling systems; vibration for dynamic cooling systems; and both the mechanical and chemical interaction of the reactor fuel, the cladding, and the reactor coolant at high temperatures. For any reactor design, technology development is required in most of these areas to assure long reactor system lifetimes. However, sufficient data are currently available to demonstrate that the potential for long lifetimes exists.

- Are there additional technological problems that must be solved in order to successfully develop a space power reactor system?

Answer

We believe we have identified all the critical nuclear technology issues that need to be addressed in the next two years. Confirmation of this belief will come from the systems design studies now underway.

- Given the magnitude of the technological problems, what are the chances of successfully designing and deploying a space power reactor?

Answer

As I indicated in an answer to an earlier question, the USSR is presently deploying space power reactors. They may not meet US success criteria or our present SP-100 Program functional requirements but they seem to do the job for which they are intended. Hence, I believe the technical feasibility of the concept has been demonstrated. In the SP-100 Program we are emphasizing safety, lifetime, reliability, performance, size, and weight. As in any engineered system, these are the kinds of parameters that can be traded off one against the other to optimize a system design. They also are the kinds of parameters that can be used to define success criteria. If your question implies deploying a space power reactor that meets the present SP-100 functional requirements then the answer is a qualified yes because there are technology areas that need to be addressed before the answer can be an unqualified yes. If, for example, the lifetime requirement is relaxed then the degree of qualification can be correspondingly relaxed.

- What funding will be needed to ground test and flight qualify the first reactor?

Answer

I cannot answer the question at this time because the answer depends on the type of system selected for ground testing and flight qualification, the kind of reactor subsystem chosen, and whether or not just the reactor or the entire system has to be ground tested. The answer to the question will be developed over the next two years as the system design work proceeds.

JOHN E. HANSON

QUALIFICATIONS

FOR SP–100 PROJECT OFFICE

DEPUTY PROJECT MANAGER

FOR NUCLEAR TECHNOLOGY

QUALIFICATIONS

SUMMARY

- 27 YEARS TECHNICAL EXPERIENCE IN NUCLEAR REACTOR DESIGN/DEVELOPMENT PROGRAMS
- 17 YEARS IN SUPERVISORY/MANAGERIAL POSITIONS OF INCREASING RESPONSIBILITY
- 13 YEARS EXPERIENCE IN MANAGEMENT OF MAJOR NATIONAL R&D PROGRAMS
- NATIONAL/INTERNATIONAL RECOGNITION IN FAST REACTOR TECHNOLOGY FIELD

TECHNICAL QUALIFICATIONS

BSME 1956 UNIVERSITY OF IDAHO

MSME 1960 UNIVERSITY OF IDAHO/GENERAL ELECTRIC SCHOOL OF NUCLEAR ENGINEERING

REGISTERED PROFESSIONAL ENGINEER

- MECHANICAL ENGINEERING, WASHINGTON & CALIFORNIA
- NUCLEAR ENGINEERING, CALIFORNIA

AUTHORED > 40 TECHNICAL REPORTS AND PAPERS

TECHNICAL EXPERIENCE

1/83: JOINED LOS ALAMOS, PGM. MGR. SPACE & MILITARY REACTORS

10/79-12/82: EG&G IDAHO, INC., PRINCIPAL ENGINEER

- TMI-2 CORE EXAMINATION PLAN
- NRC SEVERE FUEL DAMAGE PROGRAM
- NEW PRODUCTION REACTOR CONCEPT EVALUATION
- CLINCH RIVER BREEDER REACTOR LICENSING
- DOE FACT FINDING GROUP, PL96-567
- STRATEGIC PLANNING MANAGEMENT TEAM
- TECHNICAL DEVELOPMENT PROPOSAL REVIEW AND SELECTION

TECHNICAL EXPERIENCE –CONT'D.

8/66–9/79: WESTINGHOUSE HANFORD CO., MGR, FUELS SAFETY

- FAST FLUX TEST FACILITY FUEL AND CORE DESIGN/DEVELOPMENT
- PLAN/IMPLEMENT/MANAGE
  - STEADY STATE IRRADIATION TESTING PROGRAM
  - TRANSIENT IRRADIATION TESTING PROGRAM
- PRINCIPAL SPOKESMAN FOR FUELS PERFORMANCE DURING FFTF SAFETY REVIEW
- DOE FUEL ELEMENT WORKING GROUP
- DOE SODIUM BOILING WORKING GROUP
- ANS 54 COMMITTEE, LMFBR DESIGN STANDARDS

TECHNICAL EXPERIENCE - CONT'D.

7/56-7/66: GENERAL ELECTRIC CO.

1964-1966: TASK LEADER, FAST CERAMIC REACTOR PROGRAM

- BEHAVIOR OF FUEL UNDER ACCIDENT CONDITIONS

1962-1964: LEAD ENGINEER, VALLECITOS NUCLEAR LABORATORY

- DESIGN/CONSTRUCTION/OPERATION IRRADIATION EXPERIMENTS AND FACILITIES (GETR)

1956-1961: ENGINEER, HANFORD ATOMIC PRODUCTS OPERATION

- DESIGN/CONSTRUCTION/OPERATION/IRRADIATION EXPERIMENTS AND FACILITIES
    - o (KAPL 120)
    - o (KER)

PROGRAM MANAGEMENT QUALIFICATIONS

1962-1979: SUPERVISORY/MANAGERIAL POSITIONS OF
INCREASING RESPONSIBILITY

1962-1964: LEAD ENGINEER, VALLECITOS NUCLEAR LABORATORY
$10K TO $500K/YR PROGRAMS

1964-1966: TASK LEADER, FAST CERAMIC REACTOR PROGRAM
$500K TO $1M/YR PROGRAMS

1966-1979: MANAGER, FUELS SAFETY
- FFTF FUEL/CORE DESIGN/DEVELOPMENT/TESTING
- TECHNICAL DIRECTOR, IN-REACTOR TESTING, NATIONAL LMFBR SAFETY DEVELOPMENT PROGRAM

$1M TO $15M/YR PROGRAMS

Department of Energy
Washington, D.C. 20585

May 12, 1983

Honorable Marilyn Lloyd
Chairman
Subcommittee on Energy Research
and Production
Committee on Science and Technology
Washington, D.C. 20515

Dear Ms. Lloyd:

On March 8, 1983, Deputy Assistant Secretary Gordon L. Chipman, Jr. appeared before the Science and Technology Subcommittee on Energy Research and Production to discuss the authorization for advanced nuclear systems.

Following that hearing, you submitted written questions for responses to supplement the record. Enclosed are the answers to those questions.

If you have any questions, please call Diana Diamond or Tom Pretorius of my staff on 252-4277. They will be happy to assist you.

Sincerely,

Thomas H. Pretorius
for Robert G. Rabben
Assistant General Counsel
for Legislation

Enclosure

Question 1: What additional R&D activities are needed to provide the technology base for future NASA/DOD missions?

Answer: Projected space mission requirements beyond the NASA Galileo and International Solar Polar missions indicate the need for higher specific power, lighter-weight modular Radioisotope Thermoelectric Generator (RTG) power systems for future U.S. spacecraft. In concert with these forecasts, the Omnibus Reconciliation Act of 1981 contained language directing the Department to conduct basic research and development on advanced space modular isotope power systems. Accordingly, the Department continues to support the design, analysis, and evaluation of the Modular RTG. Advanced thermoelectric materials development efforts on both a near-term and long-term basis are currently in progress. For FY 1984, plans have been formulated to initiate the engineering development of an electrically heated ground demonstration system that would culminate in FY 1986 with the technology readiness of an advanced RTG space power design. Commensurate with the advanced generator converter and thermoelectric materials activities, development work is also planned to be conducted on the modular general purpose isotope heat source that would further enhance its nuclear safety characteristics and production yields.

Question 2: Is the NASA/DOD co-funding adequate in the out-years?

Answer: The funding to be provided by NASA and DOD beyond FY 1985 is undetermined at this time, but requirements are being examined now by program participants. If available funding levels should not be as high as some may equate with a fully optimum program resulting in minimum technical risk, every effort will be made to conduct a successful program within the restraints of whatever funds are provided.

Question 3: What performance improvements can we expect from the advanced modular isotope thermoelectric generator relative to current RTG's?

Answer: Significant improvements in specific power and overall system efficiency are targeted objectives. Table I, below, indicates the current comparison between the General Purpose Heat Source/RTG power sources, which are planned for use on the NASA Galileo and ISPM spacecraft in 1986, and the modular isotope advanced design.

Table I

	GPHS/RTG 1983	MITG Design - 1983
Number of Heat Source Modules	18	14
Electrical Power, watt	293	288
Generator Weight, lb.	123	68
Specific Power, watt/lb.	2.39	4.25

Question 4: Who is planning the technology activities which are to lead to the development of an advanced modular isotope thermoelectric generator? Who do you expect to be the performer of these activities?

Answer: The Department has been planning and implementing preliminary technology activities over the past several years. The ground system demonstration program is planned to commence by the end of FY 1983 and be carried forward through FY 1986. The Department's normal procurement process will be utilized for the selection of the contractor(s) to conduct these development activities.

Question 5: In the Space Reactor Development program, how much are you planning to spend in FY 1983 and FY 1984 on each of the Heat Pipe Reactor and the Alternative Concepts?

Answer: Under the current MOA funding arrangement, approximately $.5 million will be expended during the remainder of FY 1983 on heat pipe reactor development and approximately $1.3 million will be expended on other concept assessments at LANL. In FY 1984, a total of $13.0 million has been requested by all three participating agencies for the SP-100 program, of which a large fraction will be spent on several reactor concepts, including the Heat Pipe Reactor.

Question 6: Who are the performers of your efforts in Alternative Concepts, what exactly are these performers tasked to do, and how much money are each of the performers to receive in each of FY 1983 and FY 1984?

Answer: General Electric, Westinghouse, and GA Technologies are under contract ($500K each) to examine various reactor development concepts and assist in advanced program planning. Each of the contractors will be looking at three power system scenarios (baseline, backup, and growth). The baseline scenario is to meet or exceed the functional requirements (power, size, weight) using moderate extension of proven technology. The backup scenario is to meet the functional requirements but may be limited in power level due to weight, size, and performance limits caused by use of the technology affording the lowest practical development risk. The growth scenario is to provide a design which tends to optimize performance in terms of power level, weight, and size by use of advanced technologies that are considered practically achievable but assume higher risk in their development. The first phase of the contract is for nine months and each contractor will recommend a concept for each scenario, complete with supporting development plans, cost estimates, and critical needs and risks. Current plans are to make a selection of two contractors to proceed into the next detailed design phase of the program.

Question 7: How much of your planned efforts in FY 1983 and FY 1984 are in power ranges greater than 100 KWe? What justification does this Committee have in providing you funding for MWe systems which clearly are of more interest to the military community than to the civilian area?

Answer: About 5 percent of the total effort of the SP-100 program is presently devoted to power ranges greater than 100 KWe. This level of effort is subject to change as mission requirements become clearer, and would also be dependent on availability of funding. As to the justification for providing funds for military versus civilian applications, the Department and its predecessor agencies have in the past developed power systems for both purposes, and would plan to be responsive to properly authorized requirements in the future as well.

Question 8: What level of expenditures and what roles do you envisage for each of DARPA, DOE, and NASA if the SP-100 Program is carried through the ground test phase?

Answer: The current MOA covers the critical technology phase, which will last through FY 1985. The funding levels for each year through 1985 are listed in the MOA, which has been made available to the subcommittee. Funding shares for additional years of the technology phase, if any, are not yet determined, but will be established at a program review midterm in the current phase. As to the subsequent ground test phase, which may begin about 1986, costs could range up to several hundred million dollars. The main cost variables in the program at this time are the length of the development program and the extent to which critical technologies have to be developed. Major cost items include: critical technology development, subsystem development, and system ground demonstration testing. Cost estimates are currently being refined for the ground test phase and beyond.

As to future roles in the program, Department of Defense involvement in SP-100 activities may transfer from DARPA to one of the military services at about the beginning of the ground test phase. The DOE would become more directly responsible for development and testing of the nuclear reactor subsystem, and NASA would be responsible for development of the power conversion system. Other activities and responsibilities will be assigned as appropriate.

Question 9:	What are some of the specific safety considerations that must be incorporated into the design of a space nuclear reactor?
Answer:	Safety considerations include, among other matters, the ability to prevent accidental criticality, both in a potential launch pad abort (explosion) or in water immersion; the ability to reach a long-lived orbit prior to startup of the reactor; and the question of whether the reactor should be designed for burnup or re-entry if a long-lived orbit is not achieved. The various safety criteria, objectives, and considerations can be met in two major ways. The first is by system design, and the second by mission design, though in general both ways are explored. An example of a problem solved by system design is that of accidental radiation exposure during early phases of the mission. The safety features that should be incorporated include, for example, mechanical and electrical interlocks to prevent inadvertent premature reactor start-up; special neutron absorbing materials to prevent accidental criticality; and provision for rapid disassembly of the core at impact or water immersion so that the reactor cannot become or stay critical. The risks associated with re-entry can be greatly reduced by applying one or more of the following safety methods: confinement and containment; delay and decay; and dilution and dispersion.

Question 10: Is the proposed funding as specified under this Agreement adequate to assure that a "go-no go" decision can be reached in accordance with the time frame specified in the Agreement; i.e., by 1985?

Answer: Funding is generally adequate to reach a decision within the framework of two uncertainties--timing and degree of confidence. On the question of timing, the decision on whether to proceed into the ground test phase is presently planned for mid-1985, with the understanding that it might slip perhaps into early 1986. As to the degree of confidence in the decision, no decision will be made until an "acceptable" degree of confidence has been reached. The funding levels specified in the Agreement for FY 1984 and FY 1985 are intended as basic levels of support; any additional funding provided for FY 1984 and FY 1985 would provide for greater research of critical technical questions resulting in a higher degree of confidence than would be obtainable with the basic funding. It is possible that all the desired answers may not be in hand by mid-1985, but there will likely be enough information to make an informed decision on whether or not to proceed into the next phase of the program.

Question 11: Assuming the successful completion of the conceptual design phase covered by the MOA, what consideration has been given to how the follow-on ground demonstration phase might proceed, organizationally, technically, and financially. How would the cost sharing be determined?

Answer: As specified in the MOA, upon selecting a specific system for an engineering feasibility demonstration, the management arrangement will revert to the more traditional line structure with separate activities defined for each agency, and with clearly defined interfaces. The DOE would then be completely responsible at a minimum for the nuclear subsystem in any follow-on development effort. The funding of the follow-on effort will probably be shared by the developing and using agencies under the groundrules in effect at that time and consistent with any additional congressional guidance that may be provided.

Question 12: Have all the key management positions specified in the MOA been filled? I would like my staff to be given their names and phone numbers as soon as they become available.

Answer: The key management positions specified in the MOA have been filled, and the requested information has been made available to the Subcommittee staff.* The key positions are as follows:

Steering Committee

Shelby Brewer, DOE, Chairman	252-6450 *
Robert Cooper, DARPA	694-3007
Jack Kerrebrock, NASA	755-2393

Program Office

LCdr. William Wright, Program Director	694-1703
Stephen Lanes, Deputy Program Director for Nuclear Technology	353-3984
Judith Ambrus, Deputy Program Director for Aerospace Technology	755-2450

Project Office

James Kelly, Acting Project Manager	(213) 354-7956
John Hanson, Deputy Project Manager for Nuclear Technology	(505) 667-9367

*All are area code 202 unless otherwise specified.

Question 13: The Department proposes to increase the FY 1983 budget for space nuclear power by $3.5 million to a total of $6 million. How will these funds be used? Will funding for LANL's work on HPR be adequate to assure the availability of this reactor by 1985 or 1986?

Answer: Confirmation of the allocation of $3.5M additional funding has recently been received from the Congress. A plan for funding distribution is currently under evaluation by the Triagency Program Office. DOE has recommended that these funds be spent on a variety of technical activities, which in the nuclear area would include reactor concept evaluation, materials development, management and technical support, fuel development, heat pipe investigations, and other technology development tasks.

It is not feasible at this time to determine if funding for LANL's work on the heat pipe reactor will be adequate to make a decision by 1985 or 1986 or whether this reactor concept should move on to the next stage of development, a ground engineering test. No decision has yet been made to pursue the heat pipe reactor to that decision point. The heat pipe technology being developed at LANL is only one of several reactor concepts that will be evaluated over the next several years, and some of these concepts will be eliminated as the program continues toward a ground engineering test decision.

Question 14: I understand that the Department plans to extend the space reactor technology base by supporting certain activities in industry and other laboratories. Can you discuss this for the Committee? What are your objectives here?

Answer: On future technology development tasks, we intend to spend a large fraction of available funds with industry and several laboratories to assure that all reactor concepts are adequately considered. We also will conduct additional work on various technology subtasks, including reactor design, material development, shielding, instrumentation and control, and other activities, to assure a sound technological base from which to proceed with further development.

Question 15: Before this MOA was approved, DARPA and NASA issued an RFP for conceptual designs through JPL, while the Department pursued a similar program through Rockwell. Under the present arrangement, how will these contractual efforts be integrated?

Answer: All SP-100 contracts and activities are being reviewed by the joint Project Office and tasks are being integrated as appropriate. An integrated project plan will be issued in the near future. Existing systems contracts are being examined to determine what additional work, if any, should be conducted in the nuclear area.

Question 16: What is the Department's specific technical and management responsibilities within the context of this agreement?

Answer: The MOA specifies that DARPA provides the Program Director and NASA and DOE provide Deputy Program Directors. Also, DOE appoints the Deputy Project Manager for Nuclear Technology. As to DOE's specific responsibilities as Deputy Program Director for Nuclear Technology, these include the following:

- Provides to the Project Manager technical direction for all DOE activities relating to space nuclear reactor power.
- Serves as the Chief Nuclear Power Technology Official on the SP-100 Program.
- Coordinates any DOE Headquarters activity required in support of the Program Office.
- Develops budget and budget-related material required by DOE.
- Responsible for overall SP-100 safety plans and activities.

Question 17: How will funding allocation take place under this Agreement? For example, how will the DOE/NASA contributions be dispersed? Will each Agency retain control over its own funds?

Answer: As stated in the MOA, the funding channels peculiar to the individual parties may be used, but all funds will be expended in accordance with specific written direction from the Project Manager endorsed by the Program Director.

Funding will normally be transferred to the technically cognizant organization within DOD, DOE, or NASA which will, in turn, contract and monitor the appropriate work. Funding decisions will be made by the Program Office with representation from each of the three agencies.

Question 18: In view of the recently signed agreement with NASA and DOD, what do you intend to do now?

Answer: The Department of Energy will participate fully with the other agencies in all activities under the SP-100 program. These include preparation of a program management plan and a technology assessment and advancement plan, the evaluation of reactor concepts, the conduct of supporting technology development tasks, and related management and technical functions.

Question 19: Does this mean that DOE will be working with NASA and DOD to develop an integrated program plan and hopefully a management scheme for implementing the plan?

Answer: Yes. A management and technical plan has been approved in outline form and is currently being expanded and finalized for submittal to the SP-100 Steering Committee for approval.

Question 20: The DOE program has focused recently on developing alternative concepts. How many are there?

Answer: The DOE program funded three industrial contractors (GE, Westinghouse, and GA) and two laboratories (ORNL and Brookhaven). Each group proposed several concepts which were narrowed to two each, for a total of ten. These include a gas-cooled reactor, a liquid-metal cooled fast reactor, an in-core thermionic reactor, a boiling potassium cooled reactor, and other derivative concepts.

Question 21: How many contractors are involved in developing these concepts?

Answer: The main systems contractors are as mentioned in the previous answer. These include combinations of GA and Martin Marietta; Westinghouse and the Lockheed Missile and Space Company; and General Electric. Other technical support contractors under the SP-100 program include Science Applications, Inc., Fairchild Industries, Thermoelectron Co., Systems Planning Corp., and others.

Question 22: Do you intend to select a final design from among all these design concepts and contractors? Who will evaluate these concepts? Who will do the technical review?

Answer: A final design will eventually be selected from among the design concepts developed under SP-100 program auspices. Evaluation of the concept will be conducted by a number of program participants, including JPL at the systems level and LANL at the reactor technology level. The Program Office will also evaluate and review design concepts, aided by technical expertise from appropriate organizations. The initial review and narrowing of concepts (but not final selection) will occur on completion of the first systems definition studies, now scheduled early in 1984.

Question 23: Do you believe that this selection process is significantly focused to produce reliable systems?

Answer: We believe that the selection process and supporting technology development and confirmation tasks have been established in a manner that will permit appropriate attention to be directed to both systems design and technology issues. By narrowing down the number of concepts to be studied in increasing detail as the program proceeds, we believe that the most viable concept, with as few technical problems as possible (and therefore with relatively high reliability), will be identified in the selection process.

Question 24: What do you see as the phases in the program (that is, feasibility demonstration, ground engineering, flight qualification), and the appropriate schedule for these phases?

Answer: One assessment shows the program to have a duration of 10-11 years with each of the phases mentioned above being of approximately equal length. The program schedule is determined by the evaluation of the state of technology and by the urgency of user need. The phasing and schedule of the program depends on how rapidly potential users see the need for space reactors to meet mission requirements.

Question 25: Have you made any plans for developing test facilities and for funding such facilities in view of the long lead times?

Answer: Test facilities will be a factor in this program. However, it is too early in the program to determine when or where testing will take place. We plan on taking the following approach to these facilities:

1) Have government labs present their facility capabilities to the program office in May 1983 at LANL.
2) Evaluate various lab and contractor capabilities and make site visits.
3) Determine a range of facility modifications and funding requirements for the remainder of FY 1983 and the following years.

Question 26: How long before we have an operational prototype?

Answer: An operational prototype could be ready in the early 1990's, or perhaps even earlier if a firm mission need is identified by NASA or DOD.

Question 27: Please explain the steady decline in the advanced nuclear systems budget since FY 1980.

Answer: Our ANS budget has been:

(In millions)

FY 1981	FY 1982	FY 1983	FY 1984
$40.5	$37.6	$38.9	$34.1

This decline is compatible with cost sharing agreements in effect with the Department of Defense for the SP-100 and Special Applications program and with NASA for the Galileo and ISPM missions where DOE is to fund research and development and the user agencies fund hardware production.

Question 28: What project scope and time span are covered in the Memorandum of Agreement between DOE, DOD, and NASA?

Answer: The MOA extends through FY 1985 and covers the critical technology phase. The funding requirements specified in the MOA are through FY 1985.

NASA
National Aeronautics and
Space Administration

Washington, D.C.
20546

C:MDD:C-9512f

Ms. Julie Shisler
Subcommittee on Energy
Research and Production
Committee on Science
and Technology
House of Representatives
Washington, DC 20515

Dear Ms. Shisler:

Enclosed are the responses to the questions submitted by Chairman Bouquard during the March 8, 1983, hearing at which Dr. Rea of Jet Propulsion Laboratory (JPL) testified on Space Nuclear Power.

This material completes the information requested during that hearing.

Sincerely,

Lynn W. Heninger
Acting Director, Congressional
Liaison Division

Questions submitted by Chairman Bouquard during the March 8, 1983, hearing at which Dr. Rea testified.

QUESTION 1:

From JPL's perspective, what are the critical technical issues that must be resolved before a "Go-No-Go" decision on the space reactor power option can be reached? Is it reasonable to expect resolution of these questions within the time frame specified in the Memorandum of Agreement (i.e., by 1985-1986)?

ANSWER 1:

We see the critical technical issues to be system designs which can meet at wide-range of potential future mission requirements with the selection of appropriate subsystems, components and materials. Within this framework, the critical technologies are reactor design, fuel materials, heat transport, containment and structural materials, control systems, power conversion electronics, efficient thermal-to-electric conversion subsystems, stable thermal radiation surfaces and structural elements. We cannot have all of the answers to the degree we would like, but we expect to have enough information for a decision to go forward within the time frame specified in the Memorandum of Agreement.

QUESTION 2:

Dr. Rea, what does JPL perceive as potential future non-military applications of the space nuclear reactor?

ANSWER 2:

Several classes of possible future scientific missions to planets, comets and asteroids would be enabled by a nuclear reactor power system coupled with high efficiency electric propulsion systems. They include Neptune and Uranus orbiters with a Galileo-class spacecraft, and Saturn Ring investigations where a similar spacecraft would fly in a non-Keplerian orbit parallel to the rings such that the materials in the rings would be stationary with respect to the spacecraft, allowing extremely accurate observations and measurements. Comets and asteroid multi-rendezvous, sample return, landers and probes would be enabled or significantly enhanced by the system. The power system could also supply energy for a planetary station or rover.

The system could also power large manned or unmanned satellites such as a space station, where the power level would be sufficient for the use of electric propulsion for drag-makeup and station keeping. This option would significantly reduce propellant requirements.

Potential civilian and commercial missions include communications satellites (direct broadcasting, disaster control net, mobile stations support, orbiting deep space relay system, public service platform), air and sea traffic and anti-collision control (radar), holographic mapping (radar), industrial research and processing, propulsion for orbit maneuvering, weather observation (laser sounding) and ocean resources monitoring (laser).

QUESTION 3:

Dr. Rea, what is the status of the conceptual design contract? How do you plan to interface with the Department's separate contractual efforts with Rockwell?

ANSWER 3:

Three parallel contracts were let on March 7th to G.A. Technologies, Inc. teamed with Martin Marietta Corp., General Electric Company, and Westinghouse Electric Co., teamed with Lockheed. With representatives of DOE, NASA/LeRC, and LANL, our contract manager for this work has met with each of the contractor teams; their work is underway in each case. Discussions are being held with Rockwell and with appropriate individuals in DOE to ascertain an appropriate role for Rockwell. DOE has no separate contract with Rockwell at this time.

QUESTION 4:

What funding levels would you project as necessary during the technology evaluation phase?

ANSWER 4:

The technology evaluation phase which follows our present phase has not yet been scoped. Consequently, we feel that it is premature to make any estimate at this time.

QUESTION 5:

When do you foresee the first flight test?

ANSWER 5:

The necessity for a flight test has not been established. If such a test is judged to be necessary, it could probably be conducted in the 1989-1990 time frame under conditions of extreme urgency. If missions and technology evolve at a more orderly pace, the first flight test could be expected in the early 1990's.

QUESTION 6:

How long until we have an operational prototype?

ANSWER 6:

We consider an operational prototype to be a flight prototype. Thus, we believe it could be ready as early as 1989-1990, if necessary. The first one will be flight qualifiable even though it may not fly; ground testing of components will occur prior to this.

NASA

National Aeronautics and
Space Administration

Washington, D.C.
20546

C:LVN:C-9512f

Ms. Julie Shisler
Subcommittee on Energy
  Research and Production
Committee Science and Technology
House of Representatives
Washington, DC 20515

Dear Ms. Shisler:

Enclosed are the responses to the questions from Chairman Bouquard which were forwarded to us by her April 7, 1983, letter. These questions arose from the March 8, 1983, hearing at which Dr. Kerrebrock testified.

If there is any additional information that you may need, please do not hesitate to call upon us.

Sincerely,

Patrick A. Templeton
Deputy Assistant Associate
  Administrator for Legislative Affairs

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY THE HOUSE SUBCOMMITTEE ON ENERGY RESEARCH AND PRODUCTION, COMMITTEE ON SCIENCE AND TECHNOLOGY, SUBSEQUENT TO DR. KERREBROCK'S TESTIMONY ON MARCH 8, 1983.

QUESTION 1:

Will any additional expenditures and delivery schedule slippages result from the required modification of the electrically heated engineering converter?

ANSWER 1:

DOE and NASA staff are working together to solve the problem resulting from the unexpected failure of the electrically heated engineering converter to minimize the impact of the failure. No significant schedule slippages or expenditures are anticipated at this time.

QUESTION 2:

Can you define specific R&D activities on the RTG that might be needed to provide the technology base for future NASA missions?

ANSWER 2:

NASA is already conducting a limited amount of such R&D. This includes efforts to improve thermoelectric materials and basic research to advance the understanding of the nature of such materials.

QUESTION 3:

Regarding the space reactor technology (SP-100) program; will JPL, as project manager, be responsible for all SP-100 technical work, including the nuclear reactor development and safety matters? How will the DOE interface in this management hierarchy?

ANSWER 3:

JPL as Project Manager will have overall responsibility for all technical work. This will include the integration of nuclear reactor technology into the power system, technically as well as financially. The DOE, however, has appointed a Deputy Project Manager for Nuclear Technology at the Los Alamos National Laboratory, who will have the key responsibility for planning, budgeting and directing of nuclear reactor work and safety within the framework of the power system - and thus - the project. The DOE also chairs the Steering Committee and has a Deputy Program Director for Nuclear Technology in the Program Office. In addition, the DOE exercises its normal management resonsibilities over the Los Alamos National Laboratory.

QUESTION 4:

Please review the organizational structure within NASA that has been established, both at Lewis and JPL (and possibly elsewhere) to participate in this program. How will this organization interface both internally within NASA and with your partners in this Agreement?

ANSWER 4:

An SP-100 Project Office has been established at JPL. The office takes direction from the Program Director (DARPA), however, the normal management oversight at JPL and NASA are not suspended. Specific tasks of the project are carried out at LeRC. These tasks are carried out under a manager, who coordinates the LeRC effort in response to technical direction from the Project Manager and his staff at JPL. This manager is placed within the Space Technology Directorate, Space Systems Office of LeRC and normal management oversight is exercised by LeRC and NASA Headquarters.

QUESTION 5:

What would NASA anticipate its level of participation to be in a ground engineering system development phase, both financially and technically, should this follow-on phase be oriented towards military application of space reactor power systems?

ANSWER 5:

One of the tasks to be carried out during the critical technology phase of the SP-100 program is to determine schedules and costs for a ground engineering system. During this next phase, NASA expects to be involved , as during the critical technology phase, in systems integration and energy conversion related technologies. The financial involvement is too early to forecast. We do, however, expect that the ground engineering system will be applicable to both civil and military missions.

QUESTION 6:

What are the potential civilian applications of the space nuclear systems?

ANSWER 6:

While no specific applications are now planned there are a broad range of potential civil applications including Advanced Direct Broadcasting Satellites, Advanced Weather Satellites (laser sounding of atmosphere), lunar and planetary stations, outer planet exploration, advanced manned orbital facilities and central orbital power station.

QUESTION 7:

Is there a problem in defining the civilian mission because the space station and an expanded planetary exploration program have not been authorized yet?

ANSWER 7:

Missions are usually well defined as part of the planning process before they are authorized. During the SP-100 mission definition efforts we are coordinating and interacting with both the Space Station and the Planetary Exploration planning and mission definition tasks. In this way the SP-100 plans are expected to be integrated with the long range NASA plans.

QUESTION 8:

Do you believe that the potential missions have been adequately defined to develop design concepts?

ANSWER 8:

Mission definition is an iterative process; at present, we have concepts of several potential missions that might be enabled by a power system of certain characteristics. In order to define these missions better, we have to have a better understanding of the state of the technologies necessary to develop such a system. Thus, during the SP-100 program, missions will be iteratively better defined as systems concepts are being developed. We expect a few well defined missions and system concepts to be a result of our program.

QUESTION 9:

Do you believe that the DOE selection process is sufficiently focused to produce reliable systems?

ANSWER 9:

All three agencies, now party to the SP-100 program, have conducted some previous work in this area. There is a sizable study team in place now which, utilizing the results of all previous studies and the expertise gained through them, is tasked with working out a good selection process. This is a very important part of the program since it is our goal to ensure that an intelligent decision is made whether to proceed with a ground engineering system and to select the concept with the highest probability of success.

QUESTION 10:

Would it improve the chances of success to more narrowly focus the limited funds and resources on a single promising concept?

ANSWER 10:

There is an inherent danger of prematurely focussing on a single concept, since it - by necessity - would imply a single, well defined mission. Such a mission does not exist. This is precisely the reason why selected, critical technologies are being advanced during the SP-100 effort. By conducting several system definition studies we expect to focus soon on the one or two most promising concepts which would satisfy mission requirements as they emerge. We then expect to focus on the technologies that are critical to the development of those concepts. The need is to demonstrate technology readiness before the commitment to an expensive development effort.

QUESTION 11:

You compare capabilities of the radioisotope thermoelectric generator and nuclear reactor power system. What applications do you anticipate for these two systems?

ANSWER 11:

Radioisotope thermoelectric generators have applications in missions requiring up to several hundreds of watts of power. At these power levels they are simple, safe, long lived, sunlight independent power sources. Large power requirements (in the hundred kilowatt and higher range) call for nuclear reactors because of their lighter weight.

DEFENSE ADVANCED RESEARCH PROJECTS AGENCY
1400 WILSON BOULEVARD
ARLINGTON, VIRGINIA 22209

APR 25 1983

Honorable Marilyn Lloyd Bouquard
Chairman
Subcommittee on Research and Production
House Committee on Science and Technology
Suite 2321, Rayburn House Office Building
Washington, D.C. 20515

Dear Madam Chairman:

Thank you for your letter of April 7, 1983. I enjoyed my appearance before your Subcommittee on March 8, 1983.

I appreciate the opportunity to provide additional information for inclusion in the Hearing record and I have attached answers to your nine questions on space nuclear power.

Should your staff need further details regarding this subject, Mr. James Fargo (694-3237) will be happy to assist you.

RChapman
for Robert S. Cooper
Director

Attachments

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Madame Bouquard: Dr. Cooper, you note that you "can point to no formal, firm military space mission requirements for the high power capabilities afforded by nuclear systems...". How soon do you think it will be before we can expect to see firm military space mission requirements defined and promulgated officially by the DOD?

Dr. Cooper: Formal military mission requirements in the form of a MENS or Mission Element Need Statement do not ordinarily become firm until a clear, credible solution for meeting those requirements can be seen. In the case of space nuclear power, we would eventually expect to have a requirement for some mission which can be implemented only with space nuclear power or which can be substantially enhanced through the use of space nuclear power. However, it is unlikely that firm mission requirements will be defined until a viable, credible space power system concept can be put forth which offers promise for significant performance improvement and which offers a high probability of being buildable within fixed budgets and schedules. I would expect at least one space power concept to be defined and proven in perhaps three years to the point where military space projects could begin planning on it; over an additional period of a year or two, firm mission requirements could be developed. In the nearer term "need statements" may materialize which could justify some military service R&D programs in the area of space nuclear power.

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OFFICE Directed Energy Office
Defense Advanced Research Projects Agency

DATE PREPARED April 20, 1983

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Madame Bouquard: Dr. Cooper, you note that the "gap between user and developer has been one of the major obstacles to exploitation of space nuclear power in the last two decades." What other obstacles do you believe have contributed to this situation?

Dr. Cooper: Perhaps another reason that this country has not developed space nuclear power for use today is that over the past decades significant advances have been made in solar power systems to the point where they can support most of today's space missions. In addition, this country has specialized in very powerful, efficient, and compact electronics. This has enabled us to perform many tasks in space which we had originally thought might have been impossible at power levels compatible with solar supplies. Only recently in fact have projected power requirements begun to significantly outstrip the capabilities provided by solar. Another reason that the demand for nuclear power is increasing is that the Department of Defense has become more and more interested in the survivability of their very valuable satellite systems and nuclear power is likely to be much more robust than solar. Therefore, one of the obstacles standing in the way of exploitation of space nuclear power has been the relatively slow development of demands for the characteristics of space nuclear power until the present. This has changed rapidly lately as more and more future military space missions become power and survivability limited.

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Madame Bouquard: What level of expenditures and what roles do you envisage for each of DARPA, DOE and NASA for the SP-100 Program is carried through the ground test phase?

Dr. Cooper: It is a little early to predict the expenditures required for a ground test phase which might be carried on starting in 1986 or so. Such a test phase would not only assemble and test systems on the ground but would also continue technology development. This would require substantially more funding than is being provided during the current phase of technology assessment and advancement. The roles for the three agencies no doubt would be changing at this point. We would expect perhaps that the Department of Energy would be developing the reactor for actual systems and would be testing that reactor. NASA would perhaps be working on civil space missions relating to the use of space nuclear power and would perhaps be working on the power conversion system and the space systems, and control aspects of a space power system. DARPA's role traditionally is in the advanced and longer range technology, so that we would expect that the major development aspects of the program would probably be shared by the appropriate military Services in the Department of Defense. We would expect a clear definition of roles to begin emerging perhaps in 1985 as we approach the next phase of the program.

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Madame Bouquard: The MOA appears to be oriented to DARPA management objectives. How will the civilian aspects of the program be pursued and preserved?

Dr. Cooper: Civilian aspects of the program will be addressed in a number of ways. To begin with, the management structure of the program is heavily weighted with civilian expertise and involvement. At the top, the Steering Committee is chaired by the Department of Energy. While the Program Office is directed by DARPA, there are strong deputies from both DOE and NASA. Moreover, the most important part of the program is its execution and that execution is carried on by the field activities, JPL for NASA and Los Alamos for the Department of Energy. Therefore we would expect that just by the structure itself there would be sufficient emphasis on the civil aspects of the program. From a programmatics viewpoint, we are examining a wide range of missions, both military and civil. JPL and NASA Lewis Research Center are looking at the civil missions and the Navy and Air Force are helping to examine the military missions. Once a range of both civil and military missions have been defined and prioritized, detailed power system functional requirements will be developed to maximize those missions. JPL's task will be to merge the two sets of mission requirements, military and civil, so that a single common requirement comes forth. This will guide the technology program into producing a space power system that is appropriate for both NASA and Department of Defense needs.

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ACTION OFFICER/EXTENSION LCDR William E. Wright, x41703	DATE PREPARED April 20, 1983

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Madame Bouquard: Would it improve the chances of success to more narrowly focus the limited funds and resources on a single promising concept?

Dr. Cooper: Although we are not yet in a position to do so, it is the intent of this program to begin focusing towards one or two promising concepts very early in the program. We expect that the first nine month effort with our system contractors and some of the other participants in the program will be used to focus down very rapidly to one or two such concepts. In fact it is mandatory in my view that we do such a down selection process early so that we can have very well developed system concepts and that we can make a strong case that the technology is ready for such a concept. This is necessary so that we can provide a high-payoff, compelling, and credible alternative to solar power to the space mission planners. Until we are able to provide such a compelling concept, we will not be able to get firm requirements and will be unable to afford the cost of a follow-on development effort.

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Madame Bouquard: Who should provide the liaison function with the military? Who will have a large interest in determining requirements?

Dr. Cooper: Military mission requirements will evolve naturally from the advanced planning that the Navy, Air Force, and Army do in terms of long range space missions. It is important that we have liaison with these activities at several levels. In fact, we have established a group of officers in the military services at the working level to provide frequent interaction with the Program and Project Offices and to insure that information is transmitted in both directions. In addition, a senior level group will be formed to aid us in overall policy and objective determination and to insure that, in fact, the program will be successful in meeting the evolving military mission requirements.

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Madame Bouquard: Has anyone been asked to analyze the defense related applications of varying amounts of electricity in space?

Dr. Cooper: We have several contracts through the Navy and Air Force to examine just what the increased power levels and additional survivability afforded by space nuclear power can provide to military mission applications. This includes principally applications in the hundred kilowatt class (from 20 to a few hundred kilowatts), although we have done some thinking in the megawatt regime. These efforts will result in inputs to the system definition contracts in the next few months.

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Madam Chairman: Has DOE also asked someone to do such an analysis? At what level were each of the analyses funded? Is this analysis over all power levels? Is more analysis needed? How much should be spent on that? ($1 million?)

Dr. Cooper: The Department of Energy has not asked anyone to do an analysis of military mission applications to determine how the performance of applications could be enhanced through the use of space nuclear power. The current program, with DOE participation, is spending approximately $700,000 in this regard. We expect to get sufficient results from these studies to provide needed directions for the technology program.

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HEARING DATE	TRANSCRIPT PAGE NO.	LINE NO.	INSERT NO.	

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Madame Bouquard: What will happen to the identified work under the TASP program with the new agreement between NASA, DOE, and DARPA?

Dr. Cooper: Most of the TASP work will be conducted under the SP-100 Program. Before we entered into the final agreement with the Department of Energy, NASA and DARPA had outlined the spending plan for the entire FY83 TASP Program. This planning process was informally coordinated with the DOE at the working level. Some of that program has already been executed, and some of the funds are still available. What we are doing at this stage is restructuring the remaining program to insure that all Department of Energy, NASA, and DARPA objectives are fully considered and to insure that those funds are spent on the efforts which most clearly provide a good technical return. Therefore, we might expect to see some changes in the task funding plans. However, much of the work will continue.

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1984 DEPARTMENT OF ENERGY AUTHORIZATION

WEDNESDAY, MARCH 9, 1983

House of Representatives,
Committee on Science and Technology,
Subcommittee on Energy Research and Production,
Washington, D.C.

The subcommittee met, pursuant to notice, at 9:30 a.m., in room 2325, Rayburn House Office Building, Hon. Marilyn Bouquard (chairman of the subcommittee) presiding.

Present: Representatives Bouquard, Ottinger, Hall, Lundine, Walker, Lowery, and Chandler.

Staff present: Louis Ventre, counsel; Ron Williams, science consultant; David Clement, minority counsel; and William T. Harvey, minority science consultant.

Mrs. Bouquard. The subcommittee will come to order.

Without objection, our proceedings today may be covered and recorded by the media and other persons. Hearing none, so ordered.

Good morning, ladies and gentlemen. Today, we will be receiving testimony from the Department of Energy on their proposed budget for converter reactor systems and from non-Government witnesses on both the converter reactor systems program and the West Valley project. The converter reactor systems program includes research and development on high temperature gas-cooled reactors, light water reactors, and on the Three Mile Island nuclear powerplant. The West Valley project is the demonstration program authorized by this committee in the West Valley Demonstration Project Act, which was enacted in October 1980.

The committee has supported the high temperature gas-cooled reactor program because this reactor concept has several desirable safety features which, when developed, can benefit the public. These features include, among others: an inert gas coolant which simplifies reactor control and affords operators more time to plan their response to abnormal conditions, a graphite core which becomes stronger at high temperatures, and a reactor vessel which serves as a radiation shield, thereby preventing exposure to operating personnel.

In the LWR program, the committee will want to identify an appropriate research and development role for the Department of Energy. The DOE proposes to transfer from the Nuclear Regulatory Commission to itself the operation of the loss of fluid test facility [LOFT] in Idaho. Previously, the Congress was told that LOFT was to be shut down and dismantled consistent with a recommendation from the NRC's Advisory Committee on Reactor Safeguards. Chairman Fuqua and I have stated publicly that DOE will need to justify this program if it is to be funded under the Department of Energy. We hope to receive that justification today.

The Department of Energy also proposes to phase out much of the LWR extended burnup program by allowing only one utility/vendor team to participate during fiscal year 1984. I have written to the Department of Energy asking them not to terminate any utility/vendor team while the program is under consideration in Congress. I am aware that the administration believes that the private sector will continue the development of high burnup fuel without Federal assistance because the fuel vendors will have a substantial profit motive to market this type of fuel. Nevertheless, the administration proposes to continue with one utility/vendor team during fiscal year 1984. I believe that proceeding with one team will be unfair to the remaining four utility/vendor teams. In short, if all five vendors cannot participate in the program, then I believe that the program should be completely terminated.

The administration proposes to spend $37 million on Three Mile Island-related research and development. The committee has supported the Three Mile Island R&D program's efforts to glean valuable information concerning fuel failure, waste disposal, decontamination, and nuclear safety from the first commercial reactor core to suffer large-scale damage during operation.

Finally, the committee will examine the status and problems associated with the West Valley demonstration project. The Department proposes to spend $36 million in fiscal year 1984 to continue with the West Valley project. A large portion of this money will go for simple maintenance and operation of the facility, as opposed to actual research and development work on solidification. The committee is, therefore, interested in exploring the benefits of a more expedited program schedule, as well as possible negative ramifications associated with the larger, front-end expenditure of funds.

We do have a very busy schedule today, with eight witnesses slated to testify. However, we are most fortunate to have the benefit of their expertise and their counsel.

Our first witness will be Dr. Shelby Brewer, DOE's Assistant Secretary for Nuclear Energy.

Dr. Brewer, you may summarize your statement or proceed as you wish. Your written statement will be made a part of the record.

STATEMENT OF SHELBY T. BREWER, ASSISTANT SECRETARY FOR NUCLEAR ENERGY, U.S. DEPARTMENT OF ENERGY, ACCOMPANIED BY THOMAS A. WERNER, DIRECTOR, OFFICE OF CONVERTER REACTOR DEPLOYMENT, DOE, AND FRANK COFFMAN, STAFF MEMBER, DIRECTOR, OFFICE OF TERMINAL WASTE DISPOSAL AND REMEDIAL ACTIONS, THREE-MILE ISLAND

Dr. BREWER. Thank you, Madam Chairman. I have with me, on my left, Mr. Tom Werner, Director of the Office of Converter Reactor Deployment at the DOE. On my right is Dr. Frank Coffman, who is here to respond to questions on TMI, which is part of this hearing.

Today's hearing concerns the Department's converter reactor program. To give you some insight into the taxonomy of this program, there are several key elements. Light water reactor systems has as its major element the safety program, in response to Public Law 96-567 of 1980 dealing with nuclear safety——

Mrs. **Bouquard**. Excuse me, Dr. Brewer. I am going to be involved in hearings on the subject of a nuclear freeze, so Mr. Hall has agreed to chair the hearings today. I will be trying to wear two hats this morning.

Dr. **Brewer**. Thank you, Madam Chairman.

Mr. **Hall**. Please continue, Dr. Brewer.

Dr. **Brewer** [continuing]. The LOFT program, the light water reactor extended burnup program, and the light water reactor dose reduction program. The next major program element is the HTGR, and the final program element is the Three Mile Island research and development program.

DOE has two basic responsibilities at TMI under statute: first of all to provide generic research and development generally applicable to the entire industry, and second, to deal with unique waste problems for which the Department has either special responsibilities or capabilities. The total ceiling for the DOE program, as laid down by Counsellor Meese in an agreement with Governor Thornburg in October 1981, is $123 million in fiscal year 1982 dollars.

The progress to date has been good. About half of the backlog of unique waste have been removed from the island. The plan now is to open the vessel in preparation for removing the core, beginning sometime this coming summer. We hope to have the core out of Pennsylvania during fiscal year 1986.

Mr. Chairman, if you like, we have a short tape of the TMI progress. It is about 4 minutes. We will be pleased to show it.

Mr. **Hall**. Fine.

[The video tape was shown.]

TMI-2 RESEARCH PROGRAMS BRIEF

Narrative

The March 28, 1979, accident at Three Mile Island, while resulting in negligible radiation exposure to the surrounding population, caused extensive damage to the power plant itself.

Following the accident, one of the major concerns expressed by Government agencies and the general public was the fear that Three Mile Island would become a permanent disposal site for the wastes resulting from the accident and subsequent cleanup. During the past year, following execution of a memorandum of understanding between the Department of Energy and the Nuclear Regulatory Commission, the TI&EP waste immobilization program has addressed this concern by resolving the unique technical problems associated with these highly radioactive accident-generated wastes. In August 1982, the Department of Energy began shipping these wastes off TMI for characterization, interim storage, and disposal demonstration research and development programs. The majority of the liquid wastes generated during the accident have been decontaminated by the plant owner. This decontamination involved two ion exchange media systems, called Epicor Two and the Submerged Demineralizer System. The Epicor Two system ion exchange media consist predominantly of organic resins in a carbon steel container, referred to as a liner.

So far, 15 highly radioactive Epicor Two liners have been successfully prepared and shipped to the Idaho National Engineering Laboratory for research and development. Shipment of the remaining 35 Epicor Two liners from TMI is scheduled to be completed by the end of fiscal year 1983.

The Submerged Demineralizer System, or SDS, differs from the Epicor System in that the SDS exchange media is an inorganic zeolite in a stainless steel liner. The use of zeolite allows the SDS ion exchange media to be loaded with much higher levels of radioactivity, thereby reducing total waste volume.

The first SDS liner prepared by vacuum outgassing and catalyst addition was shipped from TMI in December 1982.

One data acquisition program task that had a dramatic effect on the TMI-2 recovery effort was the gross decontamination experiment conducted in March 1982, after months of preparation. This experiment was one of the necessary prerequisites for reactor vessel head removal, the first step in the defueling sequence. The objective of the experiment was to reduce radiation dose rates and loose surface contamination in the reactor building, thereby minimizing personnel radiation exposure. The experiment also involved determining the effectiveness, safety, application rates, and efficiency of several decontamination techniques.

The predominant technique, shown here, involved the use of low- and high-pressure water sprays. This technique, called hydolasing, attempted to wash the bulk of contaminant-bearing material and debris into drains that empty into the reactor building basement. From this collection point, the water could readily be decontaminated. The water used in the experiment was accident-generated water decontaminated in the early months after the accident. Recycling this accident waste water precluded the generation of additional liquid waste and did not pose processing problems that would be associated with the use of harsh decontamination chemicals.

Recent waste immobilization program activities demonstrate that handling, shipping, and disposal of special accident wastes can be safe and cost-effective.

During the past year TI&EP reactor evaluation program activities made significant progress, accomplishing major milestones in the path toward safe defueling of the severely damaged unit two core.

The single event with the greatest impact on the core removal effort occurred last summer when the first examination of the damaged unit two reactor internals was conducted. This examination, called "Quick Look" even though it took months of intensive planning and preparation, provided engineers with the first concrete evidence of the actual condition of the reactor core. This information is a prerequisite of paramount importance in overcoming the technical problems associated with removing the severely damaged core. Moreover, the quick look eliminated the uncertainty of performing work on the reactor itself, thus providing the basis for routine operations in and around the reactor vessel, which will be required for defueling.

The quick look, conducted over a three-week period, examined the core at three locations--the center, a mid-radius point, and near the outer edge. Access into the reactor at these locations was accomplished by removing the control rod drive mechanism leadscrews. The leadscrew is the component that connects the drive motor to the control rod. Once the leadscrew was removed, a miniature radiation-resistant television camera was lowered through the resulting opening to inspect the plenum and upper core region some 35 feet below.

As expected from earlier TI&EP analytical studies, the reactor core sustained considerable damage. A void area was formed when the fuel was redistributed. This void extends five feet below the normal top of active core elevation and radially outward to the area scanned at the mid-radius inspection point.

Part of the quick look inspection involved probing the rubble bed with a steel rod. The weight of the probe was sufficient to cause it to penetrate the rubble bed to a depth of approximately 14 inches. This demonstrated that at least in the probe locations and to a depth of approximately 14 inches, the rubble is comprised of loose material and is not a fused mass.

Throughout the quick look inspection, some partial melting and thermal distortion of nonfuel materials was observed. It should be noted, however, that there is no evidence that any of the uranium oxide fuel melted. Although the quick look was limited in scope and could not provide a total definition of the extent of damage, its overwhelming success has provided a solid basis for conducting future recovery activities including reactor head and plenum removal, and defueling.

The accomplishments highlighted in this videotape clearly demonstrate that significant progress is being made in all three Department of Energy TMI-2 programs. By the end of 1983, all Epicor and SDS waste will be removed from the island, the major remaining abnormal wastes will be characterized, and efforts for their removal will have begun. In addition, the reactor vessel head will be removed, and planning for the last major milestone--fuel removal--will be well under way. The advances in nuclear technology that continue to result from the Department of Energy's TMI-2 research programs are making valuable contributions that benefit the TMI-2 cleanup and recovery, as well as the entire nuclear power industry.

Dr. **Brewer**. Mr. Chairman, there are a number of program elements in the converter reactor line that are being recommended to be terminated in fiscal year 1984. The HTGR program, the light water reactor extended burnup program, and the light water reactor dose reduction program are recommended to be terminated.

This completes my oral statement, Mr. Chairman; my colleagues and I would be happy to answer whatever questions you may have.

[The prepared statement of Dr. Brewer follows:]

PREPARED STATEMENT OF SHELBY T. BREWER, ASSISTANT SECRETARY FOR NUCLEAR ENERGY, DEPARTMENT OF ENERGY

Madam Chairman, I am pleased to be back with the Committee today to discuss the Converter Reactor program. The FY 1984 budget request for Converter Reactor Systems is $53.2 million, down from $78.8 million in FY 1983. The following table reflects the breakout of these funding levels.

	(B/A in Millions)	
	FY 1983	FY 1984
Light Water Reactor Systems	$ 10.0	$ 15.0
High Temperature Reactors	35.3	0.0
Three Mile Island Activities	29.0	37.0
Advanced Reactor Systems	4.2	0.0
Program Direction	0.3	1.2

The overall goals of the Converter Reactor Systems Program are threefold: 1) to improve the efficient and safe use of converter reactors through improvements in Light Water Reactor (LWR) technology, 2) to contribute to the resolution of the nuclear industry's regulatory, financial, and institutional problems, and 3) to fulfill the Federal Government's research and development commitment associated with General Public Utilities' cleanup of Three Mile Island (TMI). In FY 1984, this program will focus on the following activities: 1) the Loss of Fluid Test (LOFT) facility; 2) research and development and information retrieval on TMI; 3) in-house regulatory, financial, and institutional analyses of obstacles to a healthy nuclear-electric industry; 4) coordination of a national LWR safety program; and 5) completion of work on a single LWR fuel design for extended burnup.

Light Water Reactor Systems

Since FY 1976, the LWR program has been concerned with developing and demonstrating technical advances in the design, manufacture, and operation of LWRs in order to enhance their safe and efficient use as a source of base-load electrical energy. Today, the major problems confronting the nuclear reactor industry are no longer technical, but are institutional, financial, and regulatory in character and as such the FY 1984 Converter Reactor Program places more emphasis on these. The foremost priority in this regard is reform of the current, inefficient NRC licensing process. I will now briefly discuss each of the Converter Reactor Program activities.

Light Water Reactor Institutional and Safety Program

The proposed LWR safety R&D program has been reoriented to provide the technology base needed to support institutional improvements in the way nuclear technology is licensed and regulated. In particular, support for nuclear regulatory reform proposals and for satisfying the requirements of the Nuclear Safety Research, Development, and Demonstration Act of 1980 (Public Law 96-567 - to develop a technical basis to effect improvements in the ability of LWR industry to produce reliable, economic, and safe nuclear power) are provided for in the FY 1984 program plan.

Our objectives pertaining to regulatory reform fall into five major categories. First, approval of standard designs. This provision would authorize the Nuclear Regulatory Commission (NRC) to approve standard designs for entire plants or subsystems so that utilities have the option of choosing a plant of preapproved design in lieu of one-of-a-kind or customized plant design. The objective is not only a major improvement in both time and dollars required to review, certify, and build a plant to meet the NRC's safety criteria, which will translate into lower costs to consumers, but an enhanced degree of public health and safety due to greater familiarity with the plant during its construction and operation.

Second, advanced site approval. This provision authorizes the NRC to approve sites for prospective nuclear plants in advance of a utility's decision to apply for permission to construct such a plant. The objective is to provide for earlier and more effective public participation in the site selection process before significant funds are expended, thereby reducing unnecessary expenses and costly planning uncertainties.

Third, integrated licensing procedures. This provision permits utilities to apply to the NRC for a construction and operating license in one proceeding in lieu of the current process whereby a construction permit and an operating license are obtained at different stages of the process. The objectives are more meaningful participation for the public, a more systematic and comprehensive review by the NRC, and greater predictability and certainty for utility planners.

Fourth, centralized review of proposed design modifications. This provision requires the NRC to provide for centralized review and approval of all backfitting proposals made by the NRC's staff. The objective is better prioritization and more logical sequencing of modifications that have been judged to offer significant safety improvement, thereby minimizing wasteful duplication of effort. In addition, criteria would be established which would require a design modification to result in a significant improvement in public health and safety when considered over the life of the plant before it could be incorporated. More attention would be paid to a proper balancing of costs to the consumer of plant backfits, and the potential improvements in their health and safety.

Fifth, improvement in the hearing process. This provision allows legislative hearings for most issues, thereby reserving adjudicatory hearings for contested issues of material fact. It also assures that issues already settled in other proceedings do not have to be reviewed again unless additional material facts are introduced. The objectives are to focus more time and resources of the NRC on substantive public health and safety issues, while at the same time permitting a more effective licensing process.

To satisfy the legislated requirements of the Nuclear Safety Research, Development and Demonstration Act, the Department will coordinate the development and implementation of a DOE/NRC/industry cooperative program to establish the priorities of institutional and technological safety issues and to determine how best to resolve these issues. The first step will be the development of a systematic and integrated approach to LWR safety.

The program is divided into two phases--a program definition phase and a program implementation phase. Program needs and priorities are being defined by utilizing working groups composed of representatives from DOE, NRC, industry, and national laboratories. DOE has convened ten of these working groups. Additionally, the three specific studies required by Public Law 96-567 (A Comprehensive Program Management Plan, The Need and Feasibility of a National Reactor Engineering Simulator, and the Sufficiency of U.S. Efforts to Provide Specially Trained Operators for Nuclear Plants) were submitted to the Congress in FY 1982.

Anticipated accomplishments in FY 1983 include:

- o Continuation of work with utilities to improve plant operators response to accident conditions and ability to restore a plant to a normal operating condition.
- o Completion by the Institute for Nuclear Power Operations (INPO) of job and task analyses for powerplant operators so that improved training programs can be developed for coping with accidents.
- o Continuation of support for and coordination of working groups developing the national safety R&D program as required by P.L. 96-567.

Expected accomplishments in FY 1984 include:

- o Support for the enactment and implementation of licensing and regulatory reform legislation.
- o Development of specific solutions to the institutional and financial problems of nuclear electric utilities.
- o Continued coordination of the national safety R&D program consistent with P.L. 96-567.

Since these activities can be accomplished with internal departmental resources, we are only requesting funding in FY 1984 for personnel positions.

Loss of Fluid Test Program

The LOFT program is an internationally funded activity. In FY 1984, this program will adapt the unique capabilities of the LOFT facility (which otherwise would be lost as current related NRC R&D programs are completed) to provide data necessary to reduce uncertainties in primary and containment system responses to severe transients and accidents. Nine tests are planned over a 3-year period with a final severe test to simulate actual fission product releases from a fuel melting accident. The program will be directed by a consortium of the participants and will rely heavily on input from the nuclear industry. The participation of industry is expected to result in a greater focus on economic as well as safety related improvements. It is estimated that program costs from FY 1983 through FY 1986 will be $93.5 million. Of this amount, $25.0 million is FY 1983 NRC LOFT program funds, $15.0 million is FY 1983 NRC funds related to LOFT decontamination and decommissioning that the NRC has committed but Congress has not yet appropriated, $30.0 million is new DOE program funds, and $23.5 million will be contributed by foreign countries.

LWR Extended Burnup

The Extended Burnup Program through FY 1983 has consisted of: first, major projects conducted by selected electric utility/LWR fuel vendor teams to evaluate the extended burnup performance of specific fuel designs, and secondly, several smaller projects to obtain basic data on extended burnup phenomena needed for design and licensing.

The planned accomplishments for the Extended Burnup program in FY 1983 include: 1) the continuation of efforts to obtain generic design and licensing data and other necessary supporting technology and 2) continuation by utility/vendor teams of major R&D projects on extended burnup in LWRs.

In FY 1984, the basic data effort will be continued using funding still available from prior years' appropriations. One major cost-shared contract with a utility/fuel supplier team will also be continued, but other major contracts will be cancelled. These efforts will complete Government support of this program. Private sector organizations such as the fuel vendors, utilities, and the Electric Power Research Institute will--if sufficient incentives exist--conduct the balance of the previously planned program activities without Government assistance.

Light Water Reactor Radiation Dose Reduction Program

No funds are being requested for this program in FY 1984. The phaseout of ongoing projects is being carried out using funds provided in prior years.

High Temperature Reactor

The High Temperature Gas Reactor (HTGR) program has been supported since 1975 because of its potential for attaining the high working temperatures that would be applicable to numerous process industries that are presently dependent on fossil energy sources. In particular, the HTGR system is ideally suited for cogeneration with central, baseloaded industrial applications such as petroleum refining, chemical and metal processing and various synfuel processes.

Since 1981, the Utility/User industry has been working with the Government to establish a lead plant project funded primarily by the private sector with the Government contributing for the first-of-a-kind research and development costs. In FY 1983, the DOE-sponsored program provides for continuation of ongoing technology development and completion of a conceptual design for the steam cycle/cogeneration configuration of the lead plant design.

In support of Administration efforts to hold down Government spending, particularly in areas where the private sector is able to continue the development of commercial technologies, no funding for the High Temperature Gas Cooled Reactor program is proposed in FY 1984. The commercial status of the HTGR, the absence of a compelling need for a new converter reactor concept at a time when there is no market for proven LWR's, and the lack of a substantive cogeneration application support this position.

Application and related design and technology studies of advanced and higher temperature modular reactor systems will be completed in FY 1983 and data will be retained for potential applications to numerous industries that are presently dependent on fossil energy sources. The program will come to an orderly closeout at the end of FY 1983.

Three Mile Island Program

The objectives of the TMI program are (1) to acquire information and conduct R&D that will substantially enhance nuclear powerplant safety, reliability, and operation, and (2) to improve the technology and procedures for safely disposing of abnormal nuclear wastes resulting from an accident.

In consonance with the Administration's policy of private sector responsibility for commercial nuclear power activities, the Department's TMI program is limited to research and development that will be of overall value to the development and safety of nuclear power and waste management. Responsibility for the costs of TMI cleanup remains with General Public Utilities (GPU), the owner of the facility.

The TMI activities are being implemented in accordance with a memorandum of understanding by DOE, NRC, the Electric Power Research Institute (EPRI), and GPU. The efforts of GPU are aimed at plant cleanup and recovery. The Department has developed a program work scope that enables obtaining important R&D information that would not otherwise be available from the TMI-2 cleanup effort. The DOE program is being conducted in a manner that avoids delaying the GPU cleanup schedule.

In accordance with a Memoranum of Understanding between the DOE and the Nuclear Regulatory Commission, the Department will acquire unique radioactive waste, including the damaged core, from TMI for research and development and for disposal.

Two subprograms compose the TMI program: the TMI Data Acquisition Program and the TMI Waste Immobilization and Reactor Evaluation Program. The FY 84 budget request for this program is $37 million as compared to $29 million in FY 83.

TMI Data Acquisition Program

The objective of this subprogram is to obtain R&D data of generic value to the safety of light water reactors.

The DOE and EPRI are sharing responsibility and costs for portions of this R&D program. Specifically, the Department is funding data gathering, research and development, and information transfer in the following major areas: instrumentation and electrical equipment survivability, behavior of radioactive products, data system and specimen achieving, and offsite fuel debris examination. EPRI has responsibility for mechanical and structural component reliability, pressure boundary recharacterization, and decontamination and dose reduction associated with the primary coolant system.

During FY 1983, the analysis of the hydrogen burn event in the TMI-2 containment will be completed and the results provided to NRC and industry for use in calibrating their analytical techniques. Technology transfer activities in the instrumentation programs will be emphasized. Techniques to requalify electrical cables in-situ will be developed.

In FY 1984, DOE plans to conduct the in-situ and offsite examination of selected instrumentation and electrical components to ascertain their condition, cause of failure, and features which affect equipment survivability. Data obtained will be used to upgrade standards and guides, resulting in improved equipment for surveillance of nuclear plants. Efforts will continue on analyzing samples to identify how various radioactive isotopes, released within the containment building during the accident, were transported and deposited. These data will be valuable in assessing the existing models for fission product release which are used in nuclear powerplant licensing. Preparation for the offsite examination of fuel debris will be continued but actual examination will not begin until after defueling starts in 1985. The computer data bank system will continue to collect, store and transfer to NRC and industry the data and documentation generated by the Department's program.

TMI Waste Immobilization and Reactor Evaluation

The objectives of this subprogram are: (1) to conduct research and development on immobilization of abnormal reactor waste products, and (2) to examine the TMI-2 reactor and core components in-situ and to support development activities associated with the reactor defueling. The data acquired will provide an improved basis for evaluation of licensing criteria and requirements, analysis of causes and consequences of accidents, and improvement of reliability of the design and operation of LWR's. This program element was initiated in FY 1982.

The waste management and immobilization activities are initially being focused on an effort to demonstrate the feasibility of vitrifying zeolite ion exchange materials. The program will have demonstrated this feasibility in FY 1983.

Beginning in FY 1983 and continuing in FY 1984, this subprogram will focus on other techniques for the treatment of abnormal wastes produced at TMI, including alternative immobilization concepts for inorganic ion exchange zeolites and organic resins, confidence testing and long term sample observation to provide a more extensive data base. Some of the areas which will be addressed include demonstration of liner disposal in a high integrity container, resin solidification and lysimeter testing. The knowledge gained will contribute substantially to the technology for processing and disposing of unique waste forms resulting from abnormal reactor operations and accidents.

The reactor evaluation activities include examination, removal, and disposition of the reactor core and internals. The special systems, equipment, facilities, and processes needed to accomplish the defueling operation, including examinations, tests, and evaluations of the fuel, will be developed.

To date, over 170 manned entries have been made into the reactor to determine both the extent of damage and the resulting program requirements. Principal efforts will be directed to the goal of removing the reactor head late in FY 1983. In parallel, the development and engineering of systems, equipment and procedures for reactor plenum removal and storage and for reactor defueling and fuel transfer will be initiated. In FY 1984, plenum removal will be accomplished and core disassembly activities will begin. Work will be directed toward preparing for a thorough examination of the reactor internals and core and performance of defueling activities in a radiation environment as low as practicable. Substantial beneficial data on the condition of the reactor core and other internal components will be obtained. In addition, preparations will be made for extensive off-site examinations of the fuel, debris and reactor internal components to characterize the accident effects.

This program will provide the data required for evaluating present licensing criteria and requirements; developing future licensing criteria; assessing and developing computer models used to analyze the course and consequences of severe accidents; developing means to mitigate the effects of such accidents; and evaluating improvements to reactor design, operation, and maintenance.

This completes my formal statement, Madam Chairman. I will be happy to answer any questions that you may have at this time.

Mr. **Hall**. Dr. Brewer, do you have a transcript of the film for the record?

Dr. **Brewer**. Yes, sir. We can provide that.

Mr. **Hall**. Thank you very much.

The gentleman from New York?

Mr. **Ottinger**. Mr. Chairman, I wonder if I might ask a couple of questions, because I have to testify.

Mr. **Hall**. I understand that we go back into session at 10 o'clock; is that correct?

Mr. **Ottinger**. That is correct.

Mr. **Hall**. The gentleman from New York is recognized for 5 minutes.

Mr. **Ottinger**. I have two things. First, Mrs. Bouquard spoke to you, Dr. Brewer, about the extended burnup program and the desire of the subcommittee to proceed with all five vendors. I understand that the Appropriations Committee has not objected to your proceeding with just one vendor. We are concerned that you do nothing to jeopardize the ability of the department to proceed with five vendors, if Congress does eventually decide to appropriate $7.5 million for that.

Dr. **Brewer**. Mr. Ottinger, we are in receipt of the letter dated February 17. We have not taken steps at this time to defer any of the projects awaiting approval or the congressional intent expressed by this committee and the Appropriations Committee.

Mr. **Ottinger**. I am pleased with that.

I wonder if you could furnish to the committee—and I just spoke to Mrs. Bouquard and she is in agreement—the Holifield tables to show the requests of the Department with respect to all of the programs.

Dr. **Brewer**. Yes, sir. We will provide that. In this particular case, the Department's request, as I recall, was about $5.8 million for the extended burnup program.

Mr. **Ottinger**. I think it is useful for us to have that information. It also indicates that the Department, as we do, has agreed that this is a worthwhile program to pursue with the five vendors. I am very pleased with that. I thank you.

Mr. Chairman, I thank you for allowing me to proceed at this time. I have no further questions.

Mr. **Hall**. The gentleman from Pennsylvania?

[The information follows:]

Department of Energy
FY 1984 Budget Request
Office of Nuclear Energy

Energy Supply R&D Appropriation
(BA in Thousands)

	FY 1983 in FY 84 Structure	FY 1984 Dept. Req.	FY 1984 Cong.
I. Converter Reactor Systems	78,832	92,339	53,190
HTR	35,288	40,000	0
LWR Systems	10,000	13,000	15,000
TMI	29,000	37,000	37,000
Adv. Reactor Sys.	4,185	0	0
Program Direction	359	2,339	1,190
II. Breeder Reactor Systems	549,874	713,325	602,525
CRBR	193,922	370,025	270,025
LMFBR Base	302,859	297,600	286,800
Water Cooled Breeder	44,984	35,500	35,500
Program Direction	8,109	10,200	10,200
III. Advanced Nuclear Systems	38,943	34,105	34,105
Space and Special Apl.	37,962	32,735	32,735
Program Direction	981	1,370	1,370

	FY 1983 in FY 84 Structure	FY 1984 Dept. Req.	FY 1984 Cong.
IV. Nuclear Fuel Cycle	42,651	313,550	41,807
Fuel Reproc. R&D	35,409	49,300	35,385
Spent Fuel Tech.	6,389	4,000	5,000
Waste & Storage Tech.	0	7,500	0
Fuels Mgmt.	0	251,000	0
Program Direction	853	1,750	1,422
V. Remedial Actions	63,396	121,165	93,985
FUSRAP	11,700	13,000	12,000
Grand Junction	1,672	1,500	1,500
UMTRAP	20,834	42,200	27,900
Surplus Fac.	12,933	19,300	15,500
West Valley	15,400	44,080	36,000
Program Direction	857	1,085	1,085
VI. Commercial Nuclear Waste	42,169	38,440	22,580
Terminal Isol. Generic R&D	22,000	12,200	4,700
Waste Systems Tech.	9,395	11,800	9,800
Waste Treatment Tech.	7,603	10,000	5,600
Pacific Northwest Lab. Landlord	2,300		2,000
Program Direction	871	4,440	480
TOTALS	815,865	1,312,924	848,192

Mr. **Walker**. Dr. Brewer, one of the controversies surrounding Three Mile Island, which I realize you do not have a direct impact on, but I wonder if from your perspective of having watched developments there you have an opinion whether or not putting unit 1 at Three Mile Island would have any adverse impact on the cleanup activities at unit 2?

Dr. **Brewer**. I will give you my personal technical opinion. My view is that it would not. Putting TMI-1 back into operation, on the other hand, would vastly improve the financial condition of GPU.

Mr. **Walker**. Which means that the dollars for cleanup of unit 2 would be more readily available? Is that a logical assumption?

Dr. **Brewer**. Yes, sir.

Mr. **Walker**. And that, in addition, you would also have an opportunity probably to move the cleanup along on schedule with those additional dollars? Is that also a reasonable assumption?

Dr. **Brewer**. Yes, sir.

Mr. **Walker**. The film referred to the benefits that extend to the entire industry as a result of the learning curve that we were developing at Three Mile Island. Could you give us some idea as to what you think the benefits to the entire industry are that we have achieved thus far?

Dr. **Brewer**. Dr. Coffman.

Dr. **Coffman**. There are many benefits that accrue to the whole industry and the country as a whole. The practical experience of decontaminating and decommissioning a unit which has had a major core accident is something that has had, and will continue to have, substantial input into the Nuclear Regulatory Commission decisions on degraded-core rulemaking. The data that we get on the releases or the absence of releases of iodine, for example, from the core will have substantial input on the siting and emergency plan activities which are coming forth.

The experience which we got on the electrical instrumentations has resulted in improvements to instruments to make them more capable of survival in water and high-radiation environments. Many of these developments should result in improvements to the safety of other plants and to the alleviation of public concern.

The accident occurred, and although it led to major core damage, no substantial radioactivity was released. As a result, it illustrates that the regulatory standards are more than adequate to protect public health and safety, and this should bode well for future reactor systems.

Dr. **Brewer**. Mr. Walker, I would like to add that the justification for the $123 million multiyear program at TMI is based on its generic R&D value. As it turns out, about half of the cost of our program displaces costs which would otherwise have to be borne in the cleanup effort.

Mr. **Walker**. Can you give me some idea as to what your opinion is of the status of industrywide help for the cleanup financing?

Dr. **Brewer**. As you know, the Governor Thornburg formula is not quite in place yet. The Heinz bill of last year did not pass. There is an intensive effort, I understand, underway now to seek voluntary contributions from the industry. I am told that this is going as well as could be expected.

Mr. **Walker**. One of my problems is, we are now 3 years or almost 4 years into the problem. The industry, it seems to me, has been very reluctant to respond. Given the kind of information that you have just given the committee, about how this is going to have industrywide benefits, why do you think the industry has been so reluctant to get on board and provide some financing of something that is obviously going to be to their benefit to have done and to have done right.

Dr. **Brewer**. There are two considerations with respect to the industry, Mr. Walker. First of all, there is the matter of the nuclear utilities, which the Heinz bill addressed by specifying a fee from all U.S. nuclear-generated electricity. The utilities have great difficulty in getting local PUC permission, for example, in Arizona, to make a contribution to an accident which occurred in Pennsylvania. That is one impediment. A second class of industrial contribution could be from the nuclear suppliers, the reactor manufacturers. In their case, their revenue base is so small in these depressed nuclear times that they simply cannot contribute in a very large way. The industry target, remember, in the Thornburg formula is about $190 million.

Mr. **Walker**. I essentially agree. I think you make two good points there. The point I had is, we had a witness before us just the other day from Gulf States Utility who, when I asked him about their participation in the voluntary plan—I am paraphrasing, and I do not want to misrepresent him—essentially said that he didn't think it was any part of their obligation to get involved and that they had other concerns that were far more pressing than doing something about Three Mile Island. That is the attitude I am concerned about, and I am wondering how widely spread that might be.

Dr. **Coffman**. I might comment on that. I have attended some of the Edison Electric Institute meetings on the subject, and I found that, by and large, the individual utilities and utility companies are very supportive of the Thornburg proposal and lobbied hard to get a mandated bill passed so that they could get these charges approved by the public utility commissions. They strongly supported the Heinz bill, which unfortunately did not pass. After that happened, the utilities met in January 1983 and tentatively agreed on a voluntary target of $150 million. When $100 million is accumulated into that fund, they will begin disbursements of that money. So I think they are trying, within the practical constraints of a regulated community, to contribute. I found them to be very strongly supportive.

Mr. **Walker**. Mr. Chairman, you have been more than generous with the time. I have two more short questions here.

Mr. **Hall**. Without objection, you may proceed.

Mr. **Walker**. We are also seeking some help at the present time, and I know the Department has been involved in seeking help on the international scale. Do you feel that progress is being made on that front?

Dr. **Brewer**. Yes, I do, Mr. Walker. I shall be going to Japan to nail that down in the next 3 or 4 weeks.

Mr. **Walker**. Are you satisfied with the schedule and with the progress being made in the cleanup at the present time?

Dr. **Coffman**. If the program had been fully funded, clearly it could have proceeded in the past 3 years faster than it has. Although they have had less than optimum funding profiles, I think the progress, particularly in the past year, has been quite good. They have fixed the crane in the containment building. They have decontaminated a major portion of the work area. All the waste backlog will be off the island by the end of fiscal year 1983. They are going to take the head off this July, and they hope to get the fuel out during fiscal year 1986. So I think the progress has been very good, considering the severe funding restraints.

Mr. **Walker**. And you are satisfied with the leadership that the company has shown in maintaining that course?

Dr. **Coffman**. General Public Utilities and their prime contractor, GPU, NC, have taken on this issue of optimum approaches in a limited funding scenario. They have reorganized, they have strengthened and streamlined their management, and I think they have done about as well as they can do, considering the practical financial limits they are working under.

Mr. **Walker**. Thank you, Mr. Chairman.

Mr. **Hall**. I understood the gentleman from Pennsylvania to indicate that there had been testimony of some reluctance on the part of industry, and you wound up your testimony by saying they were anxious to go forward with it. I am somewhat confused. There is objection, even on this panel, to a Federal contribution. If industry cannot go it alone—and I have some doubts as to whether they should—what is the future? Where are we?

Dr. **Coffman**. I would only comment that the utility industry is a community of individual utilities, with a broad spectrum of opinions. I think the heart of that community is behind either a voluntary or a mandated cleanup. There are individual utilities who simply say, "This is not my problem," but I think the base of support is strong enough and broad enough that Edison Electric Institute believes that they can either voluntarily or in a mandated manner fund the cleanup. Particularly if TMI-1 starts up, I think the resources are there to successfully complete this clean-up program, as long as the pieces continue to fall into place.

Mr. **Hall**. In the meantime?

Dr. **Coffman**. In the meantime, we are making progress, but with less funding than is desired for an expedited project.

Mr. **Hall**. Any other questions?

[No response.]

Mr. **Hall**. Dr. Brewer, thank you very much.

Dr. **Brewer**. Thank you, Mr. Hall.

Mr. **Hall**. Without objection, one of the members has asked to submit additional questions for the record. Dr. Brewer and the staff, we will submit questions to you for the record. Thank you.

Our next four witnesses will appear before us as a panel to discuss the high temperature gas-cooled reactor program. Our first witness on the panel will be Mr. Richard F. Walker, president, Public Service Co. of Colorado, and chairman, Gas-Cooled Reactor Associates. Mr. Walker last appeared before this committee in March 1982, and we welcome you back here today.

Our next witness is an old friend, Dr. Harold Agnew, who is president of General Atomic Technologies, Inc. Dr. Agnew also appeared before this committee last March, and we are delighted to have you with us again, Dr. Agnew.

The next panel member will be Robert B. Richards, who is general manager of the advanced reactor systems department of the General Electric Co. Mr. Richards was also with us last March, and we extend our welcome to you, too.

Finally, we have Mr. Robert E. Uhrig, who is vice president of the Florida Power & Light Co. Mr. Uhrig is another veteran witness before our committee, who last appeared in February 1981.

Mr. Walker, you may summarize your statement or proceed as you wish. Your written statement will be made a part of the record.

STATEMENT OF RICHARD F. WALKER, PRESIDENT, PUBLIC SERVICE CO. OF COLORADO, AND CHAIRMAN, GAS-COOLED REACTOR ASSOCIATES

Mr. R. F. WALKER. Thank you, Mr. Chairman. It is certainly our pleasure to be here and testify before your committee again this year. In the interest of time, we will give brief oral comments on our testimony, so that we will have time for questions.

Mr. HALL. Without objection, you may proceed.

Mr. R. F. WALKER. The HTGR is an advanced second generation nuclear power system that offers various distinct advantages, such as in technical, economic, and public acceptance. We believe it is one of the ideal solutions for the second coming of nuclear energy, which we all feel will come. It is a question of the time when more nuclear plants will be ordered, and there is no question in my mind and in the minds of my colleagues that we will be ordering nuclear plants in the near future, and we need to be ready for it.

Our concept has many advantages in safety, investment protection, and low radiation exposure, which has been demonstrated at the Fort St. Vrain nuclear power station, which has now operated successfully at 100 percent power. The plant is part of our system and we are proud to be the owners and operators of that plant.

Our program is focused on a lead project as the last step to commercializing the steam cycle-based HTGR technology. We have five lead project candidates as identified in the letter to Dr. Edwards and to Director Stockman last July.

Our strategy proposes a private/public cost-sharing arrangement with a 25/75-percent split—25 percent Government funding on first-of-a-kind technical development and 75 percent private financing. Further, fixed price contracts are anticipated from the vendors/suppliers. Technical progress is being accomplished with the completion of the conceptual design at the end of this year. Continued congressional support and stabilization of administration support are critical for us to keep our group together and keep this effort going. We think this program is of vital importance so we can have the HTGR option for the future.

We urge the subcommittee to continue the budget authorization for the HTGR program at DOE, as you have been so gracious in the past to do this for us. Our minimum funding level for fiscal year 1984 is $40 million, which is the same as the 1983 fiscal year funding. A more cost-effective program would call for $59 million, but we recognize the difficult budget constraints that must be considered.

We are certainly keeping our utility group going. The budget to run our organization and coordinate the HTGR program was about $2 million in 1982, and about $3 million in 1983. In my own company, we have a vital interest in this concept, and in 1982 we spent about $14 million on modifications to the Fort St. Vrain plant to further this technology, and we budgeted $20 million for 1983.

We appreciate the fine support we have had from this subcommittee and are convinced that this is the technology of the future. We have to keep a stable and ongoing program. All of us recognize that we are in a recessionary period, and no powerplants are being ordered, but that is not going to be the case too much longer. We need to be ready; we just cannot sit around and wait. We have to be ready when the time comes.

That is a very brief summary of my remarks, Mr. Chairman. We can handle the questions two ways, if you like.

[The prepared statement of Mr. Walker follows:]

PREPARED STATEMENT OF RICHARD F. WALKER, PRESIDENT OF PUBLIC SERVICE COMPANY OF COLORADO AND CHAIRMAN OF GAS-COOLED REACTOR ASSOCIATES

Madam Chairman and Members of the Subcommittee, my name is Richard F. Walker, and I am President of Public Service Company of Colorado and Chairman of Gas-Cooled Reactor Associates (GCRA). I appreciate the opportunity to present Utility/User support for the High-Temperature Gas-Cooled Reactor (HTGR) Program.

The Utility/User industry through GCRA, in conjunction with a broad sector of the nuclear industry and strong nonpartisan Congressional support has been striving to maintain a viable HTGR Program. The focus of this effort has been the development of a 2240 MW(t) Steam Cycle/Cogeneration (SC/C) Lead Project. In addition to its demonstrated application for highly efficient electricity generation, the HTGR-SC/C system is ideally suited to cogeneration applications with various industrial processes that are presently dependent on fossil energy resources. Both of these applications incorporate a single, standardized HTGR nuclear steam supply system. As an advanced, second generation nuclear power system, the HTGR offers important advantages with regard to inherent safety and low environmental impact. These features result in less reliance on engineered safety systems, added margins for meeting certain licensing criteria, greater siting flexibility, and reduced radiation exposure to plant personnel. Further, given the multibillion dollar investment of central power plants today, the HTGR's inherent safety provides important plant investment protection to both shareholders and rate payers.

As you are well aware, financial and regulatory difficulties and reduced growth in many parts of the country have resulted in the deferral or cancellation of numerous generation facilities during recent years. The industry's inability to build new capacity in the near-term implies a strong future demand for replacement and new power plants when the financial and regulatory environments are more receptive. In the interim, it is essential that the Nation maintain the foresight for continuing the development of promising energy alternatives such as the HTGR.

To date, the U.S. has invested about $1.5 billion on the HTGR. Of this total the private sector has spent approximately $1.0 billion. This support has been instrumental in the design and construction of two HTGR facilities: the Peach Bottom developmental plant which was operated by the Philadelphia Electric Company and the Fort St. Vrain demonstraton plant which is currently operating and providing electricity for the Public Service Company of Colorado (PSC).

With regard to the Fort St. Vrain plant, I am pleased to report that in November 1982 the NRC granted authorization for the plant to routinely operate at 100% power or 330 MW(e). As you know, the Fort St. Vrain power plant first went critical in January 1974 and has operated at near 70% power since January 1978. Operation was restricted to 70% capacity by the NRC until technical issues associated with core temperature fluctuations were resolved. With core restraining devices installed, a successful full power test run was authorized by the NRC and completed in November 1981. All plant systems and components performed at or near design conditions during the full-power test run. Based on these test results, PSC applied for and was granted NRC authorization to routinely operate the plant at the 100% power level. We are currently operating the plant at 70% of capacity as the result of a conscious management decision based on several factors, including the fuel warranty agreements with GA Technologies. As of year-end 1982, the Fort St. Vrain plant has delivered over 3 billion kilowatt-hours of net electrical energy.

Fort St. Vrain has provided critical confirmation and demonstration of many key HTGR concepts. In particular, fuel integrity and radiation exposure to plant personnel have had an exceptional operating record. Operating data indicate that the amount of radioactivity carried in the helium coolant has been less than two percent of the design limit, demonstrating the structural integrity of the coated fuel particles and the graphite core structure. A comparison of personnel exposure data for Fort St. Vrain and light water reactor plants in the U.S. indicates that Fort St. Vrain has had an average annual person-rem exposure rate per GW(e)-year of less than two percent of the average exposure rate in light water reactor plants. This low personnel exposure level is even more significant in view of the fact that Fort St. Vrain has virtually unlimited access into the reactor building for all operations and maintenance personnel. Other major contributions of Fort St. Vrain have been in the areas of core physics confirmation, plant control and response, and plant performance at high temperatures. Plant operating experience to date has demonstrated predictable, easily managed performance even during extreme modes of operation including temporary loss of forced cooling. The high core heat capacity has shown temperature transients to be slow, predictable, and easily controlled. Operation to date has achieved 1400°F primary loop helium temperatures, 1000°F steam temperatures, and a net efficiency of 38.5%--the highest of any nuclear plant in the U.S. We are confident that Fort St. Vrain will continue to provide valuable kilowatt-hours for the customers of PSC as well as critical information regarding the demonstration of many HTGR concepts. My company is proud of our role as owner/ operator of Fort St. Vrain.

During the past year, significant progress has been achieved in advancing the HTGR-SC Lead Project that will be the final step in commercializing the steam cycle based HTGR technology. Last July, eight senior GCRA utility executives representing five HTGR Project candidates, sent a letter to OMB Director Stockman and past DOE Secretary Edwards confirming their interest to move ahead with an HTGR Lead Project initiative. These five regional project candidates are summarized as follows:

1. In the Intermountain Region, Idaho Power Company, Public Service Company of Colorado and Colorado-Ute Electric Association would utilize the HTGR-SC/C system to meet new generation requirements. Evaluation studies have focused on the potential of such a Project located at or near the Idaho National Engineering Laboratory (INEL). Such a Project would centralize the generation capacity for sharing throughout the Intermountain Region and utilize the associated resources at INEL. In addition, the INEL site has the growth potential for a nuclear energy park with associated fuel cycle facilities and cogeneration applications. Alternatively, an Intermountain Project could be located at the Fort St. Vrain site that would accommodate a second HTGR with the attendant benefits of direct experience transfer from the Fort St. Vrain demonstration plant.

2. In the Gulf Coast Region, Gulf Oil Refining and Marketing Company has evidenced some interest in the HTGR-SC/C system as a source of cogenerated steam for its Port Arthur refinery, assuming other industrial users in the area indicate similar desires. In addition, the HTGR plant would provide electricity to the Gulf States Utilities' grid. Ongoing Project evaluation studies have indicated the feasibility of the refinery's transition from gas and oil to a central station cogeneration facility, identified potential sites proximate to the refinery, and are addressing the key institutional issues of ownership and financial arrangements.

3. In the Southeast Region, Florida Power and Light has an interest in the HTGR-SC/C system for future generation capacity at their South Dade site. This site is located in the environmentally sensitive area of Southeast Florida near large load centers experiencing rapid growth. A siting evaluation has been conducted to quantify and confirm the siting advantages of the HTGR at this site. Bob Uhrig is here today to address the Florida Power and Light interest in the HTGR.

4. In the Mid-Atlantic Region, Public Service Electric and Gas and Philadelphia Electric Company have an interest in the future electric generation and cogeneration applications of the HTGR-SC/C system. In the cogeneration application, the HTGR-SC/C system would supply process steam to industrial customers seeking to expand and/or shift from in-house gas and oil reliance or to potentially new synthetic fuel industries. Project evaluation studies have identified the cogeneration potential of the HTGR-SC/C system to such applications.

5. In the Southwest Region, Arizona Public Service (APS) has an interest in the HTGR-SC/C to meet future electric generation requirements. APS has three large nuclear reactors under construction at the present time with the last one scheduled for operation in 1986. The site at Palo Verde, west of Phoenix, is adequate to receive two additional units and is ideally suited for the HTGR. The critical water situation, siting requirements and expected need for power in the 1995-2000 time period add importance to APS's interest in the HTGR.

These identified Utilities/Users have an interest in and need for an HTGR system that would be deployed in the middle to late 1990's; hence, warranting progressive commitments during the next few years. In order to provide a framework for analyzing the financial and organizational structure required for a viable Project, GCRA in cooperation with the other Program participants has prepared a Lead Project Strategy Plan which outlines a proposed approach for completing the Project, including proposed cost and risk sharing arrangements between the public and private sectors. The July letter to Stockman and Edwards forwarded a copy of the Lead Project Strategy Plan. Both the letter and the Plan are available upon request.

The Strategy Plan poses a phased commitment to the Lead Project whereby all parties progressively develop their role and financial commitment based on solid technical and economic information, as well as institutional arrangements developed during each Project phase. The intent of this strategy is that a private sector entity will support the Lead Plant costs and risks to the extent of its commercial value. In addition, the Utility/User industry, through GCRA and EPRI, will support a share of front-end costs associated with the Lead Project. Vendor/supplier support for the Lead Project will come from an industrial team that will provide the design and manufacturing capabilities required for the Project. The vendor/supplier team would share in the Lead Project risks through firm prices on the nuclear steam supply system, including associated components and fuel supply, and provide a broad vendor/supplier infrastructure for subsequent HTGR plants. GA Technologies is committed to playing a key leadership role in establishing this vendor/supplier team. Government financial support is required for the first-of-a-kind design and technology development for systems, components, and fuel cycle. Additionally, it would provide Project financing support to offset first-of-a-kind costs and risks associated with the Lead Plant. The intent is to finance the Lead Project through a cooperative private/public sector effort with the private sector paying the major fraction, approximately 75%, of the total Lead Project costs.

In addition to the Utility/User support for a Lead Project, there has been significant progress with all elements of the HTGR Program. Utility/User financial support through GCRA and EPRI continue to grow. The utility industry spent approximately $2 million in 1982 and has budgeted about $3 million for the Program in 1983. The bulk of these resources support a full-time staff that provides Project development and integration services to the HTGR Program. In addition, the Public Service Company of Colorado has spent approximately $14 million in 1982 and has budgeted about $20 million in 1983 for Fort St. Vrain improvements that support the continued invaluable demonstration role of this plant. The vendor/supplier support has broadened and strengthened, as reflected by the increasing involvement of General Electric and Combustion Engineering along with GA Technologies for the Lead Plant's design and development activities. Even though the HTGR Program has been excluded from the Administration's budget proposals, the DOE has been supportive of the Lead Project initiative and has increasingly focused the available budget resources toward the critical path technical requirements of the Lead Project. In addition, NRC activities are responsive to the Lead Project's licensing criteria development requirements, as reflected in their HTGR Safety Research Program Plan.

With respect to government support for FY 1984, GCRA urges the House Subcommittee on Energy Research and Production to provide the DOE budget authority necessary to continue to advance the HTGR-SC/C design and technical programs and support the industry's Lead Project development activities. In support of this request I would like to reference Chairman Fuqua's letter of August 12, 1982 to DOE Secretary Edwards, which urged DOE to respond to Congress' longstanding support for the HTGR Program by giving the Program the priority it deserves in DOE's FY 1984 budget request to Congress. Your continued support in FY 1984 is crucial in our efforts to stabilize the roles of industry and government which are necessary to establish the HTGR option. To accomplish this the following tasks are scheduled during the balance of FY 1983 and in FY 1984: (a) refine and advance the Lead Project Strategy Plan, with special emphasis on establishing acceptable financial and ownership arrangements to all parties; (b) continue development of multiple Lead Project candidates through site-specific application studies; (c) complete and implement the Lead Project Management and Licensing Plans; and (d) advance the Lead Plant design through the existing baseline structure, including completion of the conceptual design, the initiation of the preliminary design and licensing, and the continuation of the fuel and component testing activities. It is also important to continue work on promising advanced HTGR systems. In particular, the Program should continue to advance the modular HTGR system by completing the concept evaluation of the modular system and to establish design and technology development requirements. For all these activities, every effort should be made to continue international cooperation with Germany and expand cooperation with Japan and others to minimize costs and risks of HTGR development. A minimum budget level of $37 million, which includes $2 million for R&D equipment, is required to adequately support these activities in FY 1984. In addition, support should continue for the HTGR thorium fuel cycle development. Work in this area should emphasize spent fuel management and continuing the cooperative technical programs with the Federal Republic of Germany. These activities will require $3 million in FY 1984.

Madam Chairman, we recognize that these budget recommendations must be considered in the context of a constrained budgetary and economic environment and in the absence of an Administration budget request to fund the HTGR Program. However, we feel that industry support for the Program and the need to maintain the HTGR option is stronger than ever. We have carefully evaluated our budget recommendations and have limited the requested funding to be consistent with the Administration's intent to freeze FY 1984 budget outlays to FY 1983 levels. If we were to proceed with the Lead Project in the most cost-effective manner, a DOE budget of $59 million would be required in FY 1984 which includes $3 million for spent fuel treatment activities. This funding level would clearly signal Congressional support for the Lead Project initiative and provide the basis for greater private sector support in 1983 and 1984. We respectfully request that the Subcommittee on Energy Research and Production also consider this proposed funding level in the course of the FY 1984 budget process.

Madam Chairman, we appreciate the opportunity to present the Utility/User viewpoint to your Subcommittee. With your continued support, we will continue to make real progress toward the realization of the HTGR technology.

Mr. HALL. I think we prefer to hear from each of you before we begin the questioning.

Dr. Agnew, you may summarize your statement or proceed as you wish. Your written statement will be made a part of the record.

STATEMENT OF HAROLD M. AGNEW, PRESIDENT, GA TECHNOLOGIES, INC.

Dr. AGNEW. Mr. Chairman, members of the subcommittee and staff, I am Harold M. Agnew, president of GA Technologies. I appreciate very much your permitting me to appear before you in support of the high temperature gas-cooled reactor.

This reactor concept is well known to you and your staff. You appreciate that it offers the unique capability to serve not only the role of electrical generation in a more efficient manner but also to serve in a second role, that of providing high-temperature steam and heat to meet the future needs of the process industry for low-cost clean energy.

The technical features of the HTGR offer to the ultimate user benefits which support its commercial development and deployment, including a substantial increase in thermal efficiency up to about 40 percent, a higher safety margin than any commercial power nuclear system, both for the health and safety of the public, and as you just saw graphically displayed in the video there, it also offers a high degree of safety as far as equity of the plant owner.

There are reduced levels of radiation exposure for operating personnel, lower levels of gaseous, liquid and solid waste discharges, reduced cooling water requirements, and that, of course, allows greater siting flexibility. On waste, in Mr. Walker's instance, his plant has produced over 3 billion kilowatt-hours of electricity and have yet to make a shipment of any low-level waste. The normal rags and all the things that accompany the other types of plants, he is yet to have to make a shipment.

These advantages accrue, I should mention, from basic technology, not from regulations or training or special gadgets. It is in the basic science and that, I guess, is what appeals to many of us in this particular era of technology.

I would ask your permission to submit for the record, along with my formal statement, a copy of this particular HTGR program report, March 1983, which supplements the information provided in my comments and further defines the technical and operations features of the HTGR. I think you are aware, since the very successful initiation of the HTGR project at Peach Bottom, which was undertaken in conjunction with 52 of the other utilities, the program has continued to show the support of a large section of our Nation's electric utility industry. This support, of course, is exemplified by the Gas-Cooled Reactor Associates, which is represented here today; Mr. Walker is the president of that organization, in addition to having the only high temperature gas-cooled reactor in this hemisphere.

Private sector participation has been a key element of the HTGR program. The HTGR is the Nation's only nuclear program which has received the majority of its development funding from the private sector. However, the proposed Government role in support of development of appropriate technology in first-of-a-kind design remains a key incentive to provide the encouragement and continuation of such private sector participation. The program submitted to the Department of Energy is based on the private sector accepting responsibility for 75 percent of lead plant program costs, representing the commercial value of the plant and related costs, with the Government providing the additional 25 percent to continue DOE research and development funds.

For its part, GA Technologies was the pioneer in the development of HTGR technology. It is currently recognized as the world leader in this field and continues to believe strongly in the concept and the contribution that it can make to meeting the world's need for clean, safe, low-cost energy. In addition to continuing investments in the technology, GA has been moving forward in parallel with the Department of Energy program and utility activities to insure having in place a strong and experienced industrial team, with the capability to undertake the design and manufacture of the HTGR nuclear system for a lead project and commercial follow-on project.

Thus, the private sector, the utility and industry investment remains paramount in the commercial development of the HTGR.

International cooperation has long been a part of the high temperature gas-cooled reactor program in the United States. A formal agreement exists between the United States and the Governments of Germany and Switzerland, providing for a cooperative exchange program for the development of the HTGR. With Japan, a number of industry-level exchange agreements are in place, and the Japanese have indicated their desire to develop closer relationships with the U.S. program on a Government-to-Government level. Mr. Brewer mentioned that he will be going to Japan in the immediate future.

The Congress of the United States, in a bipartisan effort, has long supported continued development of the HTGR, and we at GA and our utility colleagues have been greatly appreciative of this critical support. Although the HTGR has, without exception, been recommended for continued Department of Energy funding year after year in budget submissions to the Office of Management and Budget, that office has in recent years refused to support the DOE budget request. I think when you get the Holifield tables, which Mr. Ottinger requested, you will see that the DOE did request its programs be included.

Continuation of Federal support of appropriate HTGR program activities is a critical element in maintaining utility, international, public enthusiasm, and technical progress so that this nuclear system will be available as a viable option when the nuclear role in meeting the Nation's energy demands is again recognized and vigorously pursued. The HTGR may at that time be the only advanced system ready and acceptable to the public for commercial deployment. The fiscal year 1984 budget requirements set forth in the program plan submitted by the DOE for continuation of HTGR lead project and advanced system activity are $56 million, including $2 million for capital equipment and $3 million for the spent fuel treatment program. This level of activity is fully consistent with the most effective use of program resources in the initial operating of a plant by 1997.

In recognition of the constraints placed on the Federal budget, we, in conjunction with other participants in the program, have also developed the support level which, although not meeting all the goals, would provide for maintenance of critical capabilities and progress of the key critical path activities. That minimum budget would provide a total of $40 million for the HTGR lead project, advance systems, and spent fuel treatment program activities, including $2 million for equipment, approximately the same level of funding appropriated by the Congress in 1981, 1982, and 1983.

Finally, Mr. Chairman, I would again like to express my appreciation for your continued personal support and that of your committee colleagues and your staff, and I trust that your review of this program and the testimony of all the program participants before you today will provide the basis for the necessary authorization to complete the fiscal year 1984 HTGR program plan. This concludes my brief remarks, and I am willing to answer any questions you may have.

[The prepared statement of Dr. Agnew follows:]

PREPARED STATEMENT OF HAROLD M. AGNEW, PRESIDENT, GA TECHNOLOGIES, INC.

Madame Chairman and Members of the Subcommittee, I am Harold M. Agnew, President of GA Technologies Inc. I appreciate your permitting me to present the views of my company in support of a continuation of development of the High Temperature Gas-Cooled Reactor (HTGR). This advanced reactor system is well known to you and many of your Members and staff. However, allow me to quickly define its major features for those new Members who may be reviewing the FY'84 Department of Energy budget without the benefit of previous program briefings.

The historic role of nuclear power has been in electrical generation. The HTGR offers a unique capability to not only serve this role in a more efficient manner but also to serve a second role, that of providing high temperature steam and heat to meet the future needs of the process industries for low cost, clean energy. We see the long range contribution to be made by nuclear in this energy sector to be as significent as its contribution in electric generation. The HTGR is the only nuclear reactor which has this potential.

As would be anticipated with an advanced, second generation reactor the technical features of the HTGR have been selected to offer benefits to the user which support its commercial development and deployment. These benefits include a substantial increase in thermal efficiency; the highest safety margins of any commercial nuclear system; reduced levels of radiation exposures for operating personnel; lower levels of gaseous, liquid and solid waste discharge; reduced cooling water requirements; and increased siting flexibility. These benefits are not only of interest to the ultimate user but we believe can also impact upon the future acceptance of nuclear systems by the public.

The basic characteristics of the HTGR have been demonstrated by the operation of the 40 MW(e) Peach Bottom I nuclear plant during the years 1967 through 1974, and the 330 MW(e) Fort St. Vrain nuclear station, which successfully reached 100% of design power in 1981 and is continuing to verify key design features which would be incorporated in commercial scale HTGRs. The current stage of development provides the basis for the next step in the evolution of a commercial system, the construction and operation of an HTGR Lead Plant, the prime objective of which is to demonstrate a full scale commercial technology. Gas-Cooled Reactor Associates, the utility/user organization supporting the HTGR, testifying here today, will review the current Lead Plant Project activities.

Madam~~e~~ Chairman, I would ask your permission to submit for the record, along with my formal statement, a copy of a document entitled "HTGR Program, March 1983" which will supplement the information provided in this statement and further define the technical and operational features of the HTGR.

At this time I would like to turn to the omission by the Administration to include in the FY'84 budget request funding to support continued development of the High Temperature Gas-Cooled Reactor. We find this action inconsistent with strong continuing support that the program has maintained with the ultimate users of such systems, the sizeable private commitment to the program, the on-going international program activities which support the attractiveness of the concept, the documented technical achievements which have resulted from the support accorded the program and the continuing actions of the Congress to provide funding to the program.

As you are aware, since the initial HTGR project at Peach Bottom, which was undertaken in conjunction with 52 electric utilities, this program has continued to enjoy the support of a large segment of our nation's electric utility industry. This support is exemplified by Gas-Cooled Reactor Associates, which is represented here today by its Chairman, Richard Walker, who is also President of Public Service Company of Colorado. The support of the utilities results from the advanced features of the HTGR, all of which combine to provide the promise of a competitive system with enhanced environmental benefits, substantially reduced consequences to the public, the work force, and the reactor facility itself while in standard operation or during any potential accident. Through FY'82, the utilities along with GA Technologies have invested well over $1 billion to develop this technology --

our Nation's only nuclear program which has received the majority of its development funding from the private sector.

Although the base of utility support is for base load electricity production, the utilities view the application of the HTGR to industrial processes as a major opportunity to improve the future energy balance and energy economics in the United States and as an area for potential broadening of the utility role thru jointly sponsored cogeneration projects. The HTGR has the unique capability to serve a large segment of the industrial energy needs providing process steam at temperatures initially up to 1000°F. Cogeneration application studies have shown that HTGR steam electric/cogeneration systems integrate easily with major processes including those in the chemical, petroleum, shale oil, tar sands, and metal refinery industries, and that the economics are favorable when compared with the other alternatives. In the future as advanced higher temperature versions of the HTGR become available, even broader applications will become practical. The HTGR is the only nuclear technology with these unique capabilities.

Private sector participation has been a key element of the HTGR program. However, the proposed government role in support of development of appropriate technology and first-of-a-kind design remains a key incentive to encourage such private sector participation. The program plan submitted to the DOE is based on the private sector accepting responsibility for 75% of the lead plant program costs representing the commercial value of the plant and related costs, with the government providing the additional 25% through continued DOE research and development funds. For its part, GA Technologies was the pioneer in the development of HTGR technology, is currently recognized as the world leader in this field and continues to believe strongly in the concept and the contribution that it can make to meeting the world's need for clean, safe, low-cost energy. In addition to continuing investments in the technology GA has been moving forward in parallel with the DOE program and utility activities to ensure having in place a strong and experienced industrial team with the capability to undertake the design, manufacture of the HTGR nuclear system for a Lead Project and for commercial follow-on projects. Thus, the private sector utility/industry investment remains paramount in the commercial development of the HTGR.

International cooperation has long been a part of the High Temperature Gas-Cooled Reactor program in the United States. A formal agreement exists between the U.S. and the governments of Germany and Switzerland providing for a cooperative exchange program for the development of the HTGR. The benefits from such exchanges are enhanced by numerous exchange agreements existing between industrial participants in the U.S. and European programs. With Japan a number of industry level exchange agreements are in place, and the Japanese have indicated their desire to develop closer relationships with the U.S. program on a government-to-government level. Those of us in the industrial sectors in the two countries are urging ways to formalize such expanded cooperation. The common technology requirements and many common objectives of the major German, Japanese, and U.S. programs, provide a unique opportunity for instituting effective, cost beneficial joint development activities for the HTGR. We understand that the Soviet Union is also pursuing this technology.

The Congress of the United States, in a bipartisan effort, has long supported continued development of the HTGR and we at GA have been greatly appreciative of this critical support. Although the HTGR has without exception been recommended for continued Department of Energy funding year after year in budget submissions ~~to the Office~~ of Management and Budget, that office has in recent years refused to support the DOE budget request. Consequently in the FY'84 DOE budget submittal to the Congress, the HTGR is absent. As you know, the utility industry has suffered from both financial and regulatory difficulties which has impacted their current ability and need to build new capacity. We are confident, however, that when these difficulties have diminished, and when the HTGR has progressed to the point where it can be considered for commercial deployment, it will be the system of choice by reason of advanced performance, investment protection and the improved prospect for public acceptance. A continuation of federal support of appropriate HTGR program activities is a critical element in maintaining utility, international, and public enthusiasm and technical progress so that this nuclear system will be available as a viable option when the nuclear role in meeting the nation's energy demands is again recognized and vigorously pursued.

Key program goals, which I defined to you in my testimony of last year have, we are proud to say, been met with the FY'82 funds appropriated and signed into law in October of 1981. Multiple lead project candidates have been identified, in cooperation with GCRA and the DOE, a lead project strategy plan has been established, the conceptual design of the HTGR steam cycle/cogeneration reactor reached 60% completion, and the vendor/supplier team including GA, Combustion Engineering for heat exchanger support, and General Electric Company for circulator support continues. Technology development, critical to any future HTGR program, achieved major accomplishments. Construction of the developmental coater for LEU fuel particles was completed, prototypical processing units for fuel kernel manfacturing progressed, testing was performed of core models and incorporated design changes to verify the elimination of core fluctuations, preparation was made for the test facility for main circulator bearings and seals tests, air flow tests of upper and lower core plenums were initiated, and core seismic tests and correlations with structural dynamic analysis was completed. Advanced systems activities including design studies of small modular HTGR concepts also progressed.

Additionally, and of particular interest I know to you, Madame Chairman, the spent fuel treatment program under the direction of the Oak Ridge National Laboratory, completed several test runs in the cold pilot plant and completed tests on head end treatment of the German pebble bed fuel.

Activities relating to the preapplication review and safety research work at the NRC continued in FY'82 with funds appropriated and authorized by the Congress.

The FY'83 program is well on the way toward completing the lead plant conceptual design, schedule and cost estimates, completing the management plan and licensing plan, completing the transfer of steam generator technology to Combustion Engineering, completing analysis of cogeneration plant configurations, and completing licensing criteria review and documentation preparation for submittal to NRC.

Hot Cell examinations of a Fort St. Vrain test fuel element will be made, demonstration of the pilot-scale low enriched uranium (LEU) fissile kernel process is scheduled, further tests on improved fuel element designs are underway, and completion of a seismic test on full-scale section of the steam generator helical bundle is planned. With regard to advanced systems, a preconceptual design of a small modular reactor for cogeneration and process heat applications is planned. The spent fuel treatment program will complete fluid bed burner off-gas treatment testing and spent fuel transportation/storage/processing studies.

The FY'84 HTGR program plan has recently been submitted by the program participants to the DOE and with Congressional funding support, we intend to initiate the preliminary design and standard plant licensing activities, establish the basis for project ownership/financial arrangements, implement the lead project management plan, establish the reference site and initiate early site review with the NRC, complete full-scale core support performance tests in the high temperature helium test loop, initiate a full-scale partial section performance test on the core auxillary cooling system heat exchanger under normal and accident conditions, complete full-scale main circulator bearing and seal tests, and correlate USA and German experimental data in fission product transport characteristics. In the area of advanced systems we intend to initiate conceptual design and development for selected advanced HTGR systems. The spent fuel treatment program will complete spent fuel treatment studies specific to the lead plant and continue the required development program.

The FY'84 budget requirements set forth in the program plan submitted to the DOE for continuation of HTGR Lead project and advanced system activities is $56 million (including $2 million for capital equipment) and $3 million for the spent fuel treatment program. This level of activity is fully consistent with the most effective use of program resources and the initial operation of a Lead Plant by 1997. In recognition of the constraints placed on the Federal budget we, in conjunction with other of the program participants, have also developed a support level which although not meeting all goals would provide for maintenance of critical capabilities and progress on the key critical path activities. That minimum budget would provide a total of $40 million for the HTGR Lead Project, advanced systems and spent fuel treatment program activities (including $2 million for capital equipment). This is approximately the same spending level the Congress appropriated in FY's 1981, 1982 and 1983.

Finally, Madame Chairman, I would once again like to express our appreciation for your continued support and I trust your review of this program and the testimony of all the program participants before you today will provide the basis for the necessary authorization to complete the FY'84 HTGR program plan.

BRIEFING
DOCUMENT ON

HIGH TEMPERATURE
GAS-COOLED REACTOR
HTGR PROGRAM

PREPARED BY
GA TECHNOLOGIES INC.

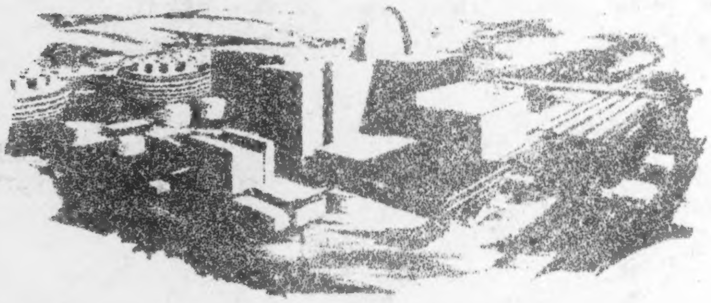
MARCH 1983

Preface

This document has been prepared by GA Technologies to provide background material on the High Temperature Gas-Cooled Reactor (HTGR) program useful to deliberations on the FY-84 nuclear budget. The HTGR program has maintained strong user support during a period of nuclear power uncertainty because the HTGR can uniquely fulfill a major role in the national energy picture, both as a second generation, safer approach to nuclear electric generation, and to supplement or displace fossil fuels in providing high temperature energy to the process industries.

During the past two years the DOE/industry program has continued to make significant progress in establishing the foundation for proceeding with an HTGR cogeneration lead plant project and in establishing the technological compatibility, environmental, and economic benefits for a number of specific cogeneration applications. Also during this period, the HTGR has been established as a leading candidate to meet the defense program need for a new production reactor.

The program participants (including the utility, process, and supplier industries) strongly urge the Congress to continue government support for the HTGR program in order to insure the availability of this unique option at such time as the institutional barriers to nuclear energy have been overcome.



Contents

HTGR Benefits 2

HTGR Steam Cycle System 4

HTGR Reactor 4
HTGR Fuel 5
Cogeneration Market 6
HTGR Cogeneration Applications 8
HTGR Safety/Environmental Features 10

HTGR Advanced Systems 11

Technology Background 12

United States Program 12
International Program 14

HTGR Program 16

Lead Plant Program 16
Other Program Activities 17
Utility and Industry Support 18
FY-82 HTGR Program Accomplishments 19
FY-83 HTGR Program 20
Recommended FY-84 HTGR Program 21

HTGR Benefits

Multipurpose Energy Roles

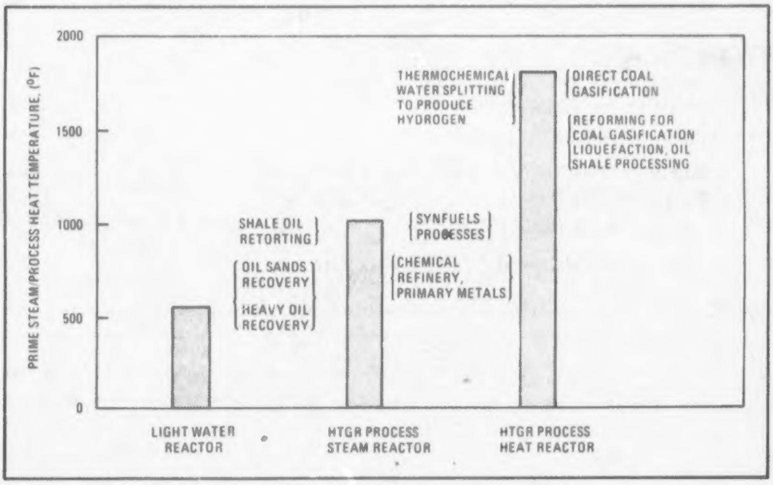
Unique capability for providing high temperature process steam or heat in cogeneration applications

- HTGR can produce 1000°F steam to meet industry needs while cogenerating electric power
- Can displace fossil fuels usage, reduce environmental impact of fossil combustion
- Future higher temperature HTGR process heat systems open additional industrial and synfuel applications for the use of clean, non-polluting nuclear process heat

Higher electricity production performance

- Higher thermal efficiency (up to 40%)
- Requires less uranium

Can contribute to all major energy demand sectors of the economy



Other Benefits

Higher levels of safety, operational and environmental compatibility

- Inherent safety results in maximum protection of public and investment, a basis for improved public acceptance
- Reduced exposures of operating personnel
- Lowest levels of gaseous, liquid and solid waste discharge
- Reduced cooling water requirements
- Improved siting flexibility

Program compatible with potential role of HTGR as a new production reactor

- Essentially all nuclear steam system hardware identical

Program can benefit from major international HTGR activities focused in Germany and Japan and recent strong interest of Japanese government in cooperative HTGR development program

Strong Industry Support

Concept has continuing support of a major segment of the nuclear utility industry, as well as major process industries

Lead plant program directed toward development of primary funding support from the private sector, direct government involvement limited to traditional front-end R & D funding

Industrial participants in program provide their individual strengths through specialized design and component design

HTGR Steam Cycle System

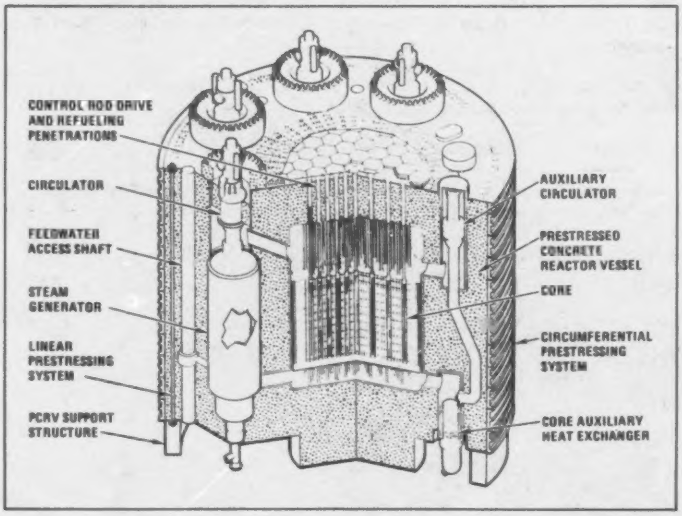
HTGR Reactor

In HTGR systems, helium gas is used as the coolant to remove the heat from the core. In the HTGR-steam electric/cogeneration system the helium is heated to about 1260°F. This heat is transferred in a steam generator to produce steam for process use and/or electricity production. The entire primary system including steam generators, helium circulators, and auxiliary heat exchangers, is housed within the thick-walled prestressed concrete reactor vessel. The fuel is contained in hexagonal graphite blocks, several thousand of which are stacked to make up the reactor core. Because of the systems high temperature capability, superheated steam can be produced, contributing to the thermal efficiency of about 40%, which is highest of any nuclear plant.

Standard Loop Design Allows Multiple Unit Rating

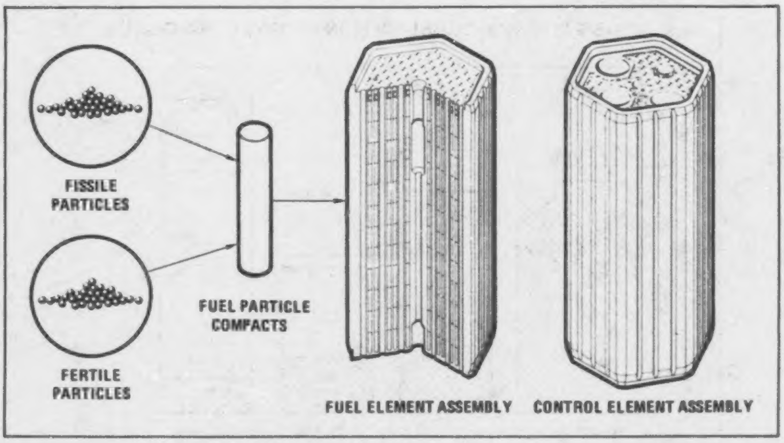
Using varying numbers of loops, HTGR system designs are available in ratings to match broad user needs

- 2 loop – 1170 MW (t) – 440 MW (e)
- 4 loop – 2240 MW (t) – 860 MW (e)
- 6 loop – 3360 MW (t) – 1300 MW (e)


CONTROL ROD DRIVE AND REFUELING PENETRATIONS
CIRCULATOR
FEEDWATER ACCESS SHAFT
STEAM GENERATOR
LINEAR PRESTRESSING SYSTEM
PCRV SUPPORT STRUCTURE
AUXILIARY CIRCULATOR
PRESTRESSED CONCRETE REACTOR VESSEL
CORE
CIRCUMFERENTIAL PRESTRESSING SYSTEM
CORE AUXILIARY HEAT EXCHANGER

HTGR Fuel

HTGR fuel is made up of tiny microspheres of uranium and/or thorium, oxides or carbides, each of which is coated with pyrocarbon and silicon carbide to retain fission products. These particles are mixed with a binder and formed into small compacts, (about 1/2 in. dia. × 2-1/4 in. long). The compacts are sealed into fuel cavities running vertically through 31 in. high hexagonal graphite fuel elements. The active core consists of stacks of these graphite fuel elements through which the helium coolant flows in vertical channels.


FISSILE PARTICLES
FERTILE PARTICLES
FUEL PARTICLE COMPACTS
FUEL ELEMENT ASSEMBLY
CONTROL ELEMENT ASSEMBLY

Fuel cycle cost advantage under comparable conditions

- Costs competitive in stow-away mode
- Cost benefits increase with increasing yellowcake (U_3O_8) costs and with recycle

Extends U_3O_8 resource base

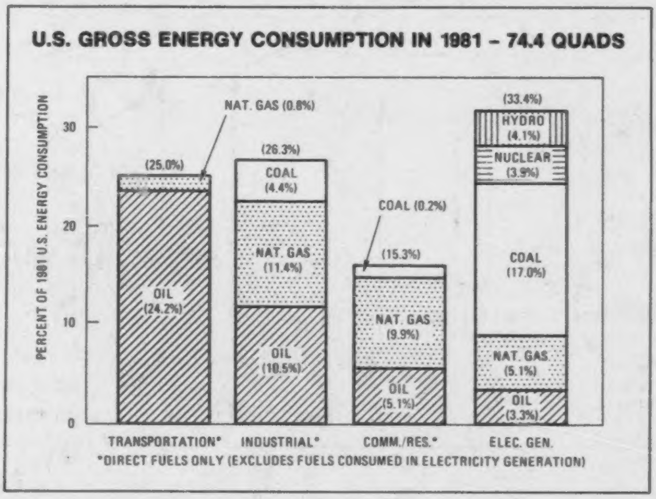
- Uses 25% to 50% less uranium than LWR depending on fuel cycle mode

Flexible uranium/thorium fuel cycle

- Can use either low or high enriched uranium cycle

Cogeneration Market

About 20 quads (26%) of the total U.S. gross energy consumption in 1981 was in the industrial sector, with the primary fuels being oil and natural gas. If electricity generated to meet industrial needs is also included, the total industrial energy consumption in 1981 was about 26 quads (35%). To avoid increases in production costs due to escalating oil and gas prices and to meet projected changes and growth in new and existing industrial processes, industry will be forced to turn to coal and nuclear fuels as alternate energy sources.



U.S. GROSS ENERGY CONSUMPTION IN 1981 – 74.4 QUADS

*DIRECT FUELS ONLY (EXCLUDES FUELS CONSUMED IN ELECTRICITY GENERATION)

Industrial energy requirements

- About 15 quads (77%) of the requirements are at temperatures of 1000°F or less
- About 9 quads (44%) of the requirements are in the form of steam

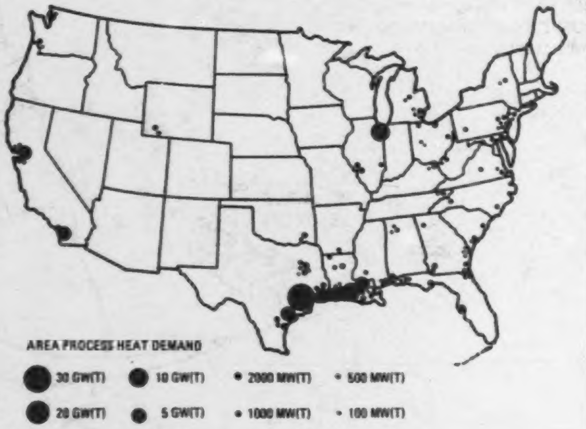
Process industries require both steam and electricity

An HTGR variable cogeneration plant can accommodate most industrial applications

Markets For Process Steam Are Concentrated

Recent studies identified current locations at which combined industrial steam requirements offer potential for the use of centralized HTGR plants to supply nuclear process steam and cogenerated electric power.

CONCENTRATIONS OF PROCESS HEAT USE



A single 1170 MW (t) HTGR cogeneration system can provide up to 2,500,000 lb/hr of process steam and from 115 to 410 MW of electricity

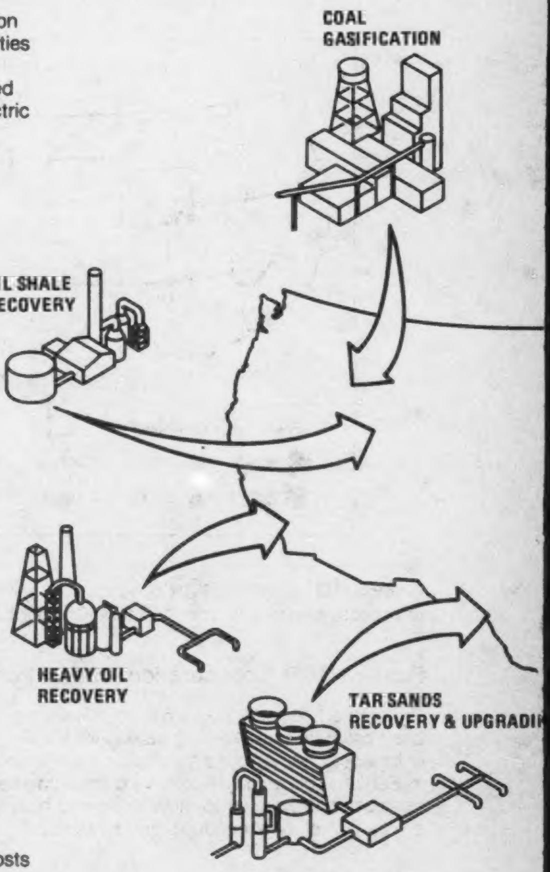
Future HTGR Cogeneration Market Potential Large

During the 2000-2020 time period, the total potential process steam market has been estimated at over 100 equivalent HTGR units of the 1170 MW (t) size. These units would be deployed to provide cogenerated steam and electric power for industrial applications. Another potential market exists for higher temperature HTGR process heat systems to meet additional high temperature needs such as the production of synthetic fuels and hydrogen.

HTGR Cogeneration Applications

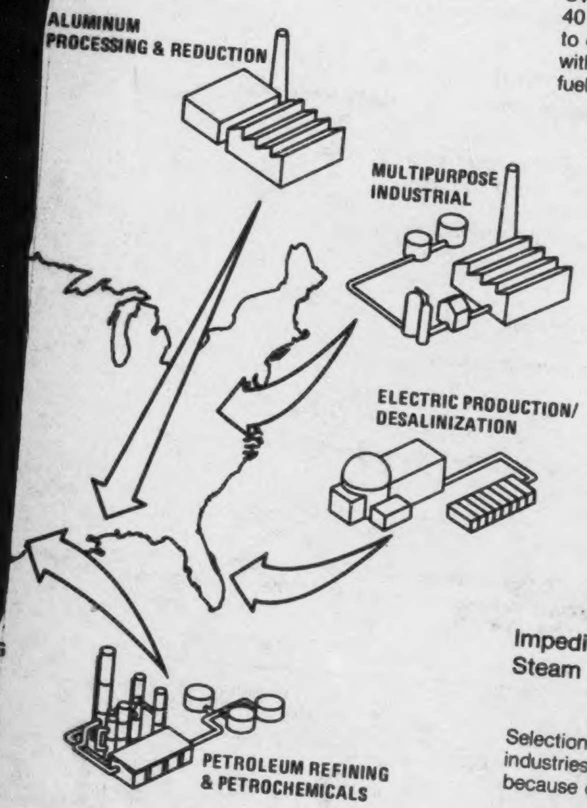
Technically Compatible

Application studies done in cooperation with major process industries and utilities show that the reference HTGR cogeneration plant design is well suited to meet most process steam and electric power requirements


COAL GASIFICATION
OIL SHALE RECOVERY
HEAVY OIL RECOVERY
TAR SANDS RECOVERY & UPGRADI

Reduced Energy Costs And Lowered Environmental Effects

For all typical applications, HTGR cogeneration systems show energy costs to be reduced by 15% to 40%, and emissions such as SO_x, NO_x, CO_2, and particulates to be lowered by 40% to 100%, when compared with coal fired alternatives


ALUMINUM
PROCESSING & REDUCTION
MULTIPURPOSE
INDUSTRIAL
ELECTRIC PRODUCTION/
DESALINIZATION
PETROLEUM REFINING
& PETROCHEMICALS

Increased Energy Utilization

Overall energy utilization increased from 40% for electric power generation only to over 90% with nuclear cogeneration, with significant conservation of fluid fossil fuel energy resources

Impediments to Nuclear Process Steam Are Institutional

Selection of nuclear process steam by industries currently difficult principally because of institutional problems

- Regulatory uncertainties
- Schedule uncertainties
- Unfavorable nuclear climate
- Higher initial cost than alternatives

HTGR Safety and Environmental Features

Higher safety level of HTGR results from inherent physical and nuclear properties

- Massive graphite core provides slow temperature response, does not require fast acting shutdown system
- Graphite core and ceramic fuel stable to extreme temperatures
- Non-reactive helium coolant
- Massive, redundant, prestressed concrete reactor vessel
- Inherent shutdown mechanisms (large negative temperature coefficient)

Inherent features are supplemented with engineered safety systems

- Independent auxiliary cooling system
- Independent emergency reactivity shutdown system
- Reactor containment building

Ample time to respond to loss of core cooling

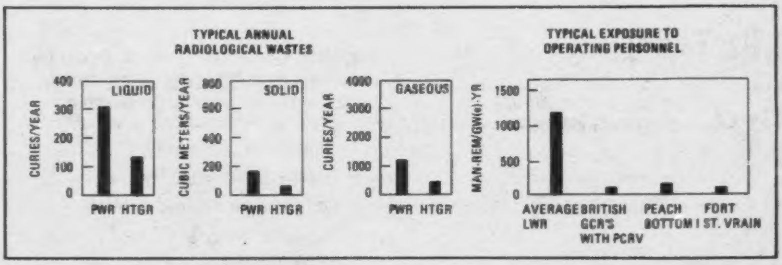
- Hours instead of minutes before damage to core

Reduced radioactivity wastes

- Helium cooled HTGR plants inherently release into the plant process streams less radioactivity than an LWR

Significantly reduced operator exposure

- Experience at Peach Bottom I, Fort St. Vrain and Gas-Cooled Reactors in the U.K. indicate that radiation exposures to operating and maintenance personnel will be about 1/10 of those for an LWR



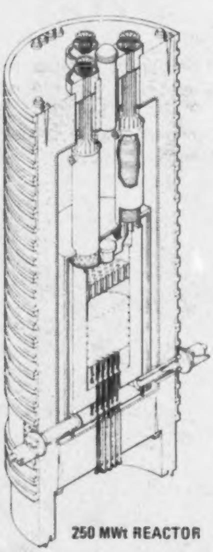
HTGR Advanced Systems

The HTGR steam cycle will provide a technical base for advanced systems with higher operating temperatures. Two such systems are the process heat and small modular reactor.

HTGR-Process Heat

The process heat HTGR provides helium core outlet temperatures of 1472° to 1652°F. An intermediate heat exchanger transfers the heat to a secondary helium loop incorporating a reformer that can be used to react steam and methane to form hydrogen and carbon monoxide, a reducing gas that can be integrated into such processes as oil shale retorting, coal liquefaction, and coal gasification, to produce transportation liquids, ammonia or synthetic pipeline gas. At higher core outlet temperatures (1652° to 1832°F) the reforming reaction can be performed more efficiently and a direct steam-coal reaction can be utilized to produce high-Btu gas or hydrogen via thermochemical water-splitting.

Small Modular HTGR



250 MWt REACTOR

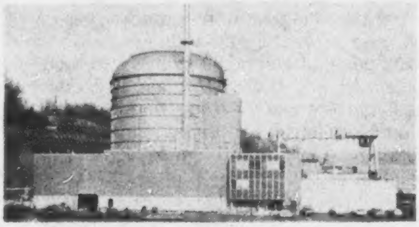
Small [250 MW (t)] modular HTGR systems (both steam cycle and reforming versions) are under assessment. The steam-cycle/cogeneration system consists of a reactor core and primary loops housed in either a steel or prestressed concrete reactor vessel. The primary coolant loop contains steam generators and horizontally mounted helium circulators. This equipment is arranged to promote natural circulation shutdown cooling of the core. In the reformer version of the small modular HTGR, an integral steam generator/reformer replaces the steam generator in the upper section of the reactor vessel.

Technology Background

United States Program

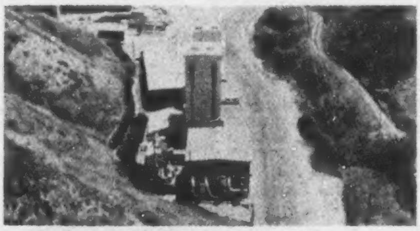
Substantial experience, technology, and test and manufacturing facilities currently exist in U.S.

Peach Bottom Unit 1



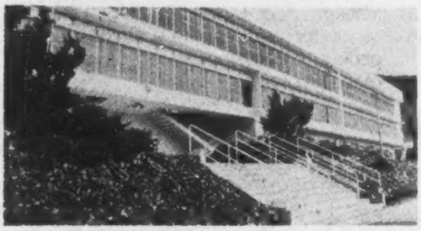
40 MW (e) Peach Bottom Unit 1 HTGR was operated successfully by Philadelphia Electric Company from 1967 to 1974, when plant was shut down for decommissioning after completing planned demonstration program.

Test Facilities



HTGR test facility compound, including air flow test facility, component test tower, PCRV models, tendon test facility, PCRV wire-winding machine, and helium circulator test facility

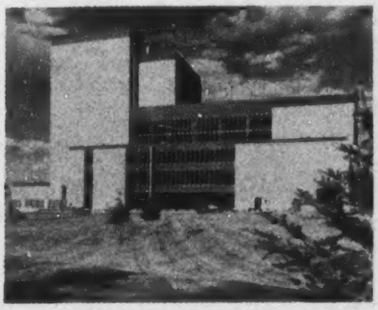
Manufacturing Facilities

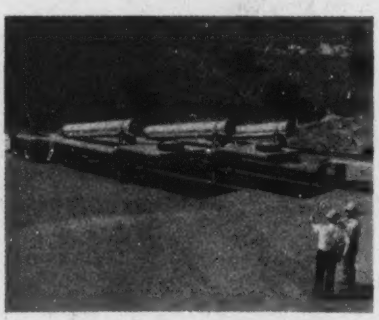


Facilities available for manufacture of HTGR fuel

Fort St. Vrain

- Obtained 100% power license on October 5, 1982
- Has operated at full power with over 38.5% thermal efficiency
- All plant systems and components have performed at design conditions
- Has generated over 3 billion kW hrs of net electrical energy to date
- Fuel performance excellent, activity in helium coolant less than 2% of design limit
- Average annual personnel exposure rate significantly less than in LWR plants, despite virtually unlimited personnel access into reactor building and absence of secondary containment
- Two segments of discharged fuel shipped to HTGR dry storage facility at Idaho Chemical Processing Plant with no problems. First operational AFR storage in U.S.





Program Funding Through 1982

Funds expended on the HTGR program through 1982, including the construction of the Peach Bottom No. 1 and Fort St. Vrain plants, amount to $1.53 billion dollars. Of this total, $555 million (or 36%) has been supplied by the government and $975 million (or 74%) has come from industry.

International Program

Experience

Substantial international experience on gas-cooled reactor technology supports U.S. program

Germany

- AVR – 15 MW(e) HTGR with pebble bed fuel has generated 1.2 million MW/hr since startup in 1967
- THTR-300 MW(e) HTGR with pebble bed fuel – PCRV pressure test carried out in September 1982, rise to power scheduled in late 1984
- Broadly based HTGR program with long term goal of nuclear coal gasification, strongly supported by coal/utility industries
- Funding in 1983: $250 million for THTR-300 and $75 million for R & D

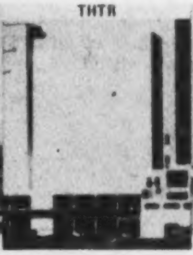
United Kingdom

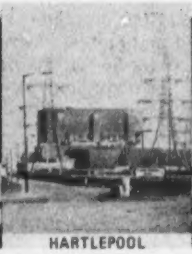
- Over 555 reactor years of operating experience with gas-cooled reactors
- DRAGON – first HTGR, operated from 1964-1975
- AGRs – 8,800 MW(e) program of seven 2-unit stations going well, both in construction and operation
- Hartlepool, Heysham 1 and Dungeness B AGR stations going on line during 1983
- Heysham 2 and Torness AGR stations in construction for operation in 1987-1988

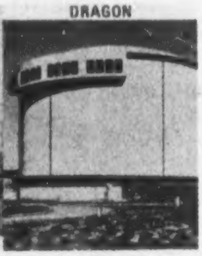
France

- Over 100 reactor years of operating experience
- Carmen II facility – core-flow and hot duct tests conducted – capability for steam generator boiling stability tests

AVR

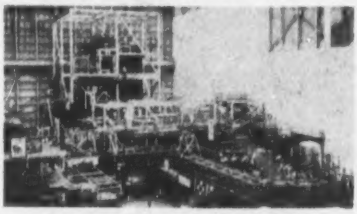

THTR


HARTLEPOOL


DRAGON

Japan

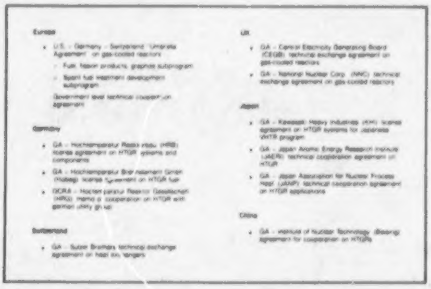
- Multi-purpose very high temperature gas-cooled reactor (VHTR) under development since 1969
- Operation of 50 MW (t) experimental VHTR in 1990 confirmed as goal in government's nuclear energy development program
- Hendel 10 MW helium test loop facility began operation in 1982 at 1000°C temperatures
- Interested in HTGR cooperation with U.S.
- Cogeneration HTGR evaluation initiated by nuclear supplier group in 1982 in cooperation with U.S. industry



HENDEL

Technical Exchange Agreements

Relevant HTGR experience is brought into the U.S. program through government and industry exchange agreements



HTGR Funding Through 1982

	Million $
Federal Republic of Germany	$1,700
Japan	300
France, United Kingdom, Switzerland	250
Total	$2,250

HTGR Program Description

The current government/industry HTGR program, which is focused on the development and demonstration of a commercial-scale HTGR steam cycle cogeneration system, has broad industry, user, and national laboratory involvement

GA Technologies, the world leader in HTGR technology, is the lead industrial firm involved in the program. However, other experienced industrial companies are also directly involved in key areas

- General Electric Company
- Combustion Engineering Company
- Bechtel Group Inc.
- United Engineers & Constructors

HTGR program activities are also conducted at National Laboratories

- Oak Ridge National Laboratory
- Los Alamos National Laboratory
- Brookhaven National Laboratory
- Idaho National Engineering Laboratory

Gas-Cooled Reactor Associates (GCRA), represents the utility/user interests in support of the program, and performs an overall program integration activity for the government

Lead Plant Program

The major fraction of the HTGR program activities are directed toward technology development and design support activities to allow a commitment to an HTGR lead plant project

Objectives

The major objectives of the lead plant project include

- Demonstration of full commercial scale HTGR systems and components including features incorporating technology evolution and Fort St. Vrain operational experience
- Establishing the licensing criteria for follow-on commercial HTGR systems
- Confirming incentives of the HTGR nuclear system for electric production and cogeneration
- Establishing a broad industrial infrastructure to support a subsequent commercial HTGR industry

Schedule

The lead plant program schedule is dependent upon the level of funding available but is directed toward completion of project definition activities and a conceptual design in 1983 with commercial operation in the 1996 to 1997 period.

Lead Plant Funding Approach

A key project definition phase task is to develop management, funding, and risk sharing arrangements

- Industry to bear the major portion (commercial value) of the lead project costs
- Direct government participation limited to front-end support of design and development
- HTGR lead plant project costs are estimated to total about $2.14 billion (in 1983 dollars), with $506 million (or 24%) coming from the government and $1,635 million (or 76%) being furnished by industry.

Other Program Activities

In addition to primary efforts on base technology development and the steam electric/cogeneration lead plant project design and applications, the HTGR program also includes other secondary and complimentary activities

- Conceptual design of higher-temperature versions of the HTGR (e.g., reforming process heat HTGR)
- Feasibility assessment of small [approx. 250 MW (t)], modular HTGR systems for electric/cogeneration and process heat applications
- Investigation of waste treatment and spent fuel storage for near-term closure of the HTGR fuel cycle, plus continued development of technology for eventual reprocessing of HTGR-type uranium/thorium fuel elements
- Development of safety/licensing criteria specific to the HTGR, and review of long-range research plans for verification of HTGR safety
- International cooperation

Utility and Industry Support

Electric Utility Support Thru GCRA

- In 1978 a utility organization, Gas-Cooled Reactor Associates (GCRA), was formed to provide support and guidance to program. GCRA utilities currently represent over 30% of installed electric generating capacity in United States, over 25% of on-line nuclear capacity and about 40% of nuclear capacity now under construction.

American Public Power Association
Arizona Public Service
Colorado-Ute Electric Association
Delmarva Power & Light
Empire State Elec. Energy Research Corp.
    Central Hudson Gas & Electric
    Consolidated Edison
    Long Island Lighting
    New York State Electric & Gas
    Niagara Mohawk Power
    Orange & Rockland Utilities
    Rochester Gas & Electric
Florida Power & Light
Gulf States Utilities
Idaho Power
National Rural Electric Cooperative Association
Northeast Utilities
    Connecticut Light & Power
    Hartford Electric Light
    Western Massachusetts Electric
    Holyoke Water Power
Pacific Gas & Electric
Pacific Power & Light
Philadelphia Electric
Public Service of Colorado
Public Service of New Mexico
Public Service Electric & Gas
Puget Sound Power & Light
Salt River Project
San Diego Gas & Electric
Tennessee Valley Authority

Industrial User Support

- In 1979 a group of major industrial firms formed a process heat users group to support continued development of HTGR. Most of these companies merged into a process heat advisory committee established by GCRA in 1981

Allied Chemical
Consolidated Natural Gas Service
Gulf Oil
Inland Steel
Kaiser Aluminum & Chemical
Mobil Research & Development
Owens-Corning Fiberglass
Scallop Coal
United Gas Pipe Line

In August 1982 GCRA sponsored its fourth annual HTGR utility/user conference, which was attended by over 200 representatives of industry, government, and utilities from 75 organizations and six countries.

Group, In
Engineer
tomic Co
ectric C
s & Con

FY-82 HTGR Program Accomplishments

HTGR Steam Cycle/Cogeneration Lead Project

- Identified multiple lead project candidates through site-specific/application studies
- Established lead project strategy plan as framework for lead project deployment
- Established initial baseline for design and technology development activities through broad review by program participants
- Completed 60% of conceptual design
- Advanced vendor/supplier team through GA subcontract arrangements with CE for heat exchanger support and GE for circulator support

Technology Development

- Completed construction of developmental coater for LEU fuel particles
- Completed prototypical processing units for fuel kernel manufacturing
- Performed testing of core models and incorporated design changes to eliminate fluctuations
- Prepared test facility for main circulator bearings and seals tests
- Initiated air flow tests of upper and lower core plenums
- Completed core seismic tests and correlations with structural dynamic analysis

Advanced Systems

- Initiate design studies of small modular HTGR concepts
- Initiated development of new wrought alloys for high temperature applications

Spent Fuel Treatment Program

- Performed several test runs in cold pilot plant
- Completed tests on head end treatment of German pebble bed fuel

NRC Safety/Licensing Activities

- Completed topical reports on HTGR safety for NRC review
- Initiated source term study for HTGR

FY-82 NATIONAL PROGRAM FUNDING

FOR HTGR APPLICATIONS AND BASE TECHNOLOGY	*$35 MILLION*
FOR SPENT FUEL TREATMENT PROGRAM	*$ 3 MILLION*
FOR NRC SAFETY/LICENSING ACTIVITIES	*$ 4 MILLION*

FY-83 HTGR Program

HTGR Steam Electric/Cogeneration Lead Project

- Advance lead project candidates and lead project strategy plan through site-specific and application studies
- Complete conceptual design, schedule, and cost estimates with associated documentation
- Complete management plan and licensing plan for lead plant project
- Complete transfer of steam generator technology to Combustion Engineering
- Complete analysis of cogeneration plant configurations
- Complete licensing criteria review and prepare documentation for submittal to NRC

Technology Development

- Perform hot cell destructive examination of FSV test fuel element
- Demonstrate pilot-scale LEU fissile kernel process through final heat treating
- Perform tests on improved fuel element design to verify elimination of core temperature fluctuations
- Complete 1/6 scale air flow model test of the core lower plenum, steam generator inlet sections and auxiliary heat exchanger inlet sections
- Complete a seismic test on full-scale section of steam generator helical bundle

Advanced Systems

- Complete preconceptual design of small modular reactors for cogeneration and process heat applications
- Establish advanced systems design and technology development requirements

Spent Fuel Treatment Program

- Complete fluid-bed burner off-gas treatment test program
- Complete lead plant spent fuel transportation/storage/processing studies

NRC Safety/Licensing Activities

- Interact with NRC on source term study and safety research program

FY-83 NATIONAL PROGRAM FUNDING:

FOR HTGR PROJECT AND BASE TECHNOLOGY	*$36 MILLION*
FOR SPENT FUEL TREATMENT PROGRAM	*$ 3 MILLION*
FOR NRC SAFETY/LICENSING ACTIVITIES	*$ 4 MILLION*

Recommended FY-84 HTGR Program

HTGR Steam Electric/Cogeneration Lead Project

- Initiate preliminary design and licensing phase
- Establish project ownership/financial arrangements
- Implement lead project management plan
- Establish reference site (s) and initiate early site review with NRC
- Complete full-scale core support performance test in high temperature helium test loop
- Initiate full-scale prototype hot duct test in high temperature helium test loop
- Initiate full-scale partial section performance test on the core auxiliary cooling system heat exchanger under normal and accident conditions
- Complete full-scale main circulator bearing and seal test
- Correlate USA and German experimental data in fission product transport characteristics

Advanced Systems

- Initiate conceptual design and development for selected advanced HTGR system with emphasis on international cooperation

Spent Fuel Treatment Program

- Complete spent fuel treatment study for lead plant and continue required development program

NRC Safety/Licensing Activities

- Initiate standard plant issue review
- Continue safety research and licensing criteria development

RECOMMENDED FY-84 NATIONAL PROGRAM FUNDING:

FOR HTGR LEAD PROJECT AND ADVANCED SYSTEMS	*$37 TO 56 MILLION*
FOR SPENT FUEL TREATMENT PROGRAM	*$ 3 TO 5 MILLION*
FOR NRC SAFETY/LICENSING ACTIVITIES	*$ 3 MILLION*

(LOWER VALUE REPRESENTS THE CRITICAL CAPABILITIES LEVEL)

Mr. HALL. Dr. Agnew, thank you.

Dr. Richards, You may summarize your statement or proceed as you wish. Your written statement will be made a part of the record.

STATEMENT OF ROBERT B. RICHARDS, GENERAL MANAGER, ADVANCED REACTOR SYSTEMS DEPARTMENT, NUCLEAR FUELS AND SPECIAL PROJECTS DIVISION, GENERAL ELECTRIC CO.

Mr. RICHARDS. I am Robert B. Richards, general manager of the Advanced Reactor Systems Department of General Electric Co. Our department is assigned the responsibility for the managing of all reactor and fuel cycle development work that has eventual commercial application, with the exception of the light water reactor applications.

We at General Electric have participated in the HTGR program for a number of years now. We have a keen interest in it, and we feel we have made important contributions to it. We said in earlier years that our main interest really focuses on the high potential of this reactor concept, to make possible the utilization of high temperature process heat that will serve to conduct chemical process, petroleum conversion processes and so forth in the future. The HTGR is the only reactor concept at the present time that has that potential.

I am going to comment on three main points today, the first being General Electric's participation in the lead project. This is the steam cycle cogeneration plant that others have referred to. We are involved in that. We are contributing in areas of systems engineering, plant dynamics and control, and we are very much supportive of the present strategy of the program as put together by GCRA, since it does involve doing a great deal of thorough upfront design and development work so that when the private sector can pick up the project and run with it, the risk will be well defined, and the cost will be well defined, and the safety characteristics will be well defined.

We endorse this approach on the lead project, and we are pleased to see also that GCRA is making good progress in identifying some potential process heat users in the future. We think that we will help in any way we can to encourage and to enlarge this type of market possibility in the future.

I want to mention one aspect of the HTGR program in which we at General Electric are involved, and that is the work that we are doing on the advanced modular HTGR. The modular unit is a small HTGR, about 200 to 300 megawatts thermal. It is small enough that it can be almost entirely factory fabricated. It could be quality controlled in the factory. It could be shipped perhaps by rail car or by barge. It is a view of a reactor system that would be designed to reduce very substantially what might be the big problem we have today in large plants and that is the construction time.

The modularization of a process-heat energy source also might provide greater availability to a process user that may require very high availability by putting several module units in combination at a particular process-heat site. This could very well expand some of the future potential markets for the HTGR with this kind of technique.

We think that perhaps it would be easier to confine and estimate what the capital risk might be to any investor coming into the business, when he could probably get a closer and more precise estimate of what his capital costs are going to be. The modular also has the advantage, too, of perhaps reducing R&D and testing costs, since it may be possible with these modular units to test the full-size module at some reasonable cost and reduce concerns about the scale-up to larger capacity units.

We think that this is an attractive technology. We think it is an approach that lends itself very well to possible future international cooperation with, for example, West Germany and Japan. We are going to urge strongly, of course, that this portion of the program, this advanced modular work, be continued and continue to receive your support.

One final set of comments that I think should be made, and one of our main interests in the process-heat type of application, the HTGR, is the matter of the impact on the environment. We pointed out previously that the substitution of nuclear heat sources for fossil fuels—coal, oil, and so forth—can provide positive benefits in the areas of conservation of resources and the cleanliness of our environment. While coal reserves are very large, it seems to us that they can be put to cleaner, more efficient uses than is obtained simply through direct-burning methods.

While we now appear to have an oil glut, this probably will not last forever, and transportation will always have the first call on oil reserves. We think that the eventual conversion of coal to liquid fuels can greatly extend our capability to satisfy this demand which now uses about one-fourth of the energy consumed in the United States.

On the matter of the environment, as we expand the application of nuclear heat sources for the cogeneration of electricity and process heat, we think we are moving in the direction of reducing those very annoying problems of acid rain and the greenhouse effect, both of which have been attributed, at least in part, to the burning of fossil fuels.

We all know that the solution to these distressing problems will not come overnight. It would appear prudent, therefore, to develop a technology base that could eventually offer real solutions to the undesirable side effects of continuing to use fossil fuels as we do today. We believe that the HTGR, when developed to its full potential, can play a major role in providing these solutions. That concludes my remarks, and we will be ready to answer any questions.

[The prepared statement of Dr. Richards follows:]

Prepared Statement of Dr. Robert B. Richards, General Manager, Advanced Reactor Systems Department, Nuclear Fuels and Special Projects Division, General Electric Co.

HTGR TESTIMONY

My name is Robert B. Richards. I am General Manager of the Advanced Reactor Systems Department of the General Electric Company. Our Department is responsible for the management of all Reactor and Fuel Cycle Developments that have commercial nuclear power as their eventual application with the exception of the light water reactor applications.

As we have pointed out in previous appearances before you, the General Electric Company has a keen interest in the HTGR program. We feel we have made important contributions in the past and look forward to continuing our involvement in the future.

Our principal interest has been on the high potential of the HTGR to generate very high temperatures that may have utilization by the process industries - chemical, petroleum, etc. No other reactor system at the present time possesses such a potential to serve the process heat market.

HTGR LEAD PLANT

General Electric is contributing to the design of the steam cycle/ cogeneration lead plant. Our contributions are primarily in the areas of systems engineering and plant dynamics and control. The program being proposed by GCRA is one that calls for DOE support during the R&D and preliminary design phases - with the work being carried out with such thoroughness that industry, users and investors, can assess the risks of conducting a future project under private sponsorship. We in GE believe this to be a proper approach to HTGR development and compatible with the intentions of the Administration and the DOE to encourage greater involvement of the private sector. We also welcome GCRA's strong efforts to encourage interest and participation by potential process heat industrial users. We hope to continue to enlarge our participation in the lead plant project.

ADVANCED MODULAR HTGR

The present GCRA/DOE development program also includes work to develop a modular gas cooled reactor - capable of generating higher temperatures than possible in the present lead project. GE has been assigned the technical lead for this phase of the program.

The modular units are of small capacity - 200-300 MWt. It is quite possible that these units could be fabricated and quality controlled in a factory and shipped in a nearly complete state via rail car or barge. Several such units could make up a process heat plant and should have a reduced construction schedule as compared to that of conventional large reactors.

The modularization of process heat energy sources could provide a higher availability to the user by creating a miniature energy source grid, or network, as a feature of the plant. The successful development of this modular concept could expand the accessible HTGR process heat markets to those where high temperatures and high availability are particularly important.

The potential result of these innovative features when applied to the fabrication, construction and operation of the nuclear process heat plant is that capital risk can be significantly reduced to the investor/user.

The smaller size of the modular reactor also lends itself to lower R&D and testing costs since the testing of a full-size module may be possible at an affordable cost. Concern with scale-up to large capacity plants can also be eliminated - capacity increases can be made simply by adding modules.

We believe that this modular technology can provide an attractive basis for expanding international cooperation, particularly with the countries of West Germany and Japan who have active HTGR programs for process heat development, while at the same time reducing the development costs incurred by each country. We strongly urge that the advanced HTGR work continue to receive your support.

MERITS OF NUCLEAR PROCESS HEAT

We have pointed out previously that the substitution of a nuclear heat source for fossil fuels (coal, oil, etc.) can provide positive benefits in the area of the conservation of resources and of the cleanliness of our environment.

While coal reserves are very large, it seems to us that they can be put to cleaner, more efficient uses than those obtained simply through direct burning methods. While we now appear to have an oil glut, this probably won't last forever and transportation will have first call on oil reserves. Eventual conversion of coal to liquid fuels can greatly extend our capability to satisfy this demand which now uses about one-fourth of the energy consumed in the United States.

Concerning our surrounding environment, as we expand the application of nuclear heat sources for the cogeneration of electricity and process heat, we believe we are moving in the direction of reducing those very annoying problems of acid rain and the greenhouse effect both of which have been attributed at least in part to the burning of fossil fuels.

We all know that the solution to these distressing problems will not come overnight. It would appear prudent, however, to develop a technology base that could eventually offer real solutions to the undesirable side effects of continuing to use fossil fuels as we do today. We believe that the HTGR, when developed to its full potential, can plan a major role providing these solutions.

BIOGRAPHY

ROBERT B. RICHARDS

Dr. Richards is General Manager, Advanced Reactor Systems Department, Sunnyvale, California.

He joined the Research Laboratory of General Electric in 1947 and later that year transferred to the Hanford Atomic Laboratory where he served in a variety of managerial positions. He transferred to the Atomic Power Equipment Department, San Jose, California in 1957 and was appointed Manager, Engineering, and served in that capacity until January 1968 when he was appointed Manager, Engineering of the Reactor Fuels and Reprocessing Department. In October 1971, he was appointed Manager, Special Fuel Programs, with overseas licensing responsibilities for the Nuclear Energy Division. Dr. Richards was appointed Manager, International Business Development, Overseas Projects Department in January 1973. He assumed his present position in 1974.

Dr. Richards was graduated from Pennsylvania State University with a B. S. in chemical engineering and an M.S. and Ph.D. in organic chemistry. He is a member of the National Academy of Engineering, Fellow ANS, Fellow AIChe, R.E. Wilson Award in Chemical Engineering in 1970, and is a Professional Engineer in the State of California.

Mr. HALL. Dr. Richards, thank you. We will save the questions until Mr. Uhrig has testified.

The Chair recognizes Mr. Uhrig. You may summarize your statement or proceed as you wish. Your written statement will be made a part of the record.

STATEMENT OF ROBERT E. UHRIG, VICE PRESIDENT, FLORIDA POWER & LIGHT CO.

Mr. UHRIG. Thank you, Mr. Chairman. I am Robert Uhrig. I am vice president, Florida Power & Light Co., with headquarters in Miami.

We are a major nuclear utility. We have three nuclear units on line today; two units at Turkey Point, south of Miami, and the St. Lucie Unit I up near Fort Pierce. Last year, that particular unit operated with a load factor of over 94 percent, which is the best in the United States. Our unit II at St. Lucie is nearing completion. If we load fuel before the end of this month as expected, we will have built that plant in under 70 months, which I think speaks well of our project group. With the completion of that plant, there will be a release of some of the manpower devoted there, and we expect some additional involvement on a technical basis with the Gas-Cooled Reactor Associates review of the technical aspects of the HTGR next year.

Most of our need for electricity is concentrated in three counties in southeast Florida: Dade, Broward, and Palm Beach. Therefore, it is very desirable that we have a site located close in to these metropolitan areas. The only nearby site that we have is our South Dade site. We believe that it is very important that we develop this particular site. It is simply not appropriate for coal because of the transportation problems; hence, nuclear is the only appropriate type of generation. Furthermore, we believe that the unique characteristics of the HTGR make it most appropriate for that particular site.

We have carried out a study, using United Engineers & Constructors, Bechtel, General Atomic, and GCRA, to determine how a HTGR would fit on that site. In every case we find the HTGR to have advantages over the alternatives that are available.

There are several things that I think are essential in the development of the HTGR: No. 1; there has to be stability to any proposed project, in the sense that a utility or any group of utilities that undertake to build one of these plants has to know that the technology support is going to be available and that the program is going to be supported politically as well as from a licensing standpoint.

The licensing issue, of course, is a very critical one because the licensing has to be realistic in the sense that it recognizes the unique advantages of the HTGR. It makes no sense to try to force an HTGR into the mold of a standard plan for a light water reactor.

As far as our present situation is concerned, we have recently signed contracts to bring electricity in from Georgia. We are building two 500-kilovolt lines all the way down the State from the Georgia border to Miami. This effectively puts off any additional need for electrical capacity out into the midnineties, which is consistent with the time that a HTGR could be available. That completes my testimony, Mr. Chairman.

[The prepared statement of Mr. Uhrig follows:]

Prepared Statement of Robert E. Uhrig, Vice President, Florida Power & Light Co.

Madam Chairman and Members of the Subcommittee, my name is Bob Uhrig, and I am a Vice President of Florida Power and Light Company (FP&L) and a member of the Management Committee of Gas-Cooled Reactor Associates (GCRA). I appreciate the opportunity to outline for you why we are interested in the HTGR.

In order to do this, I would like to tell you about my company. FP&L is one of the few utilities that has been experiencing continued growth in baseload demand. We have a total of about 2.4 million customers and continue to add about 100,000 customers per year. At the present time our system has about 13,000 MW(e) capacity and we have reached new peaks in both summer load and winter load for five of the last six years. Further, FP&L is one of the largest oil-burning utilities in the United States, having burned 40 millon barrels of oil each year in 1980 and 1981. Now that is a very dubious distinction because oil is subject to supply interruptions and unpredictable price changes. During that same time period, we also burned about 14 million barrels equivalent of natural gas. In addition we have contracts to buy power from Georgia that will expire in the mid-90's, so we are going to be needing some alternative power generation capacity in the timeframe that the HTGR could be deployed.

FP&L has three operating nuclear plants, about 2200 MW(e), and we are in the final stages of a fourth one, St. Lucie II on the East Coast near Fort Pierce. If we meet the commercial operation date by June 1983, we will have put the plant into commercial service in 72 months after the construction permit was issued. Overall, the licensing and construction experience and schedule for St. Lucie II has been exceptional. That means that we have a very competent and experienced nuclear project group.

FP&L's electrical demand is highly concentrated with about 70% of our usage located in three counties in southeast Florida. These are the Dade, Broward, Palm Beach counties which include the cities of Miami, Fort Lauderdale and West Palm Beach. However, our system extends all the way to the Georgia border and over to the west coast of Florida. To minimize power transmission costs, FP&L has a policy of locating generation capacity near load centers. For the highly concentrated southeast region the only site that would be appropriate for additional baseload generation capacity additions is our South Dade site, which is about 30 miles south of Miami. In the early 1970s, we expected to put six 800 MW(e) oil units on the South Dade site. The 1973 OPEC embargo changed all of that. In 1975, we ordered two PWR plants for that site and a year later cancelled them because of regulatory and financial considerations.

Since the South Dade site is on Biscayne Bay and connects directly to the Atlantic Ocean, open-loop cooling using ocean water is simply not appropriate because of the shallow bay areas and the high temperatures that would be created. We either have to use water out of the Floridian aquifer, which is about 1200 feet deep, or we have to use tertiary water from a nearby sewer plant that is planned for the late 1980's. For that reason, the high efficiency and low water usage of the HTGR makes it an extremely attractive option. Further, the low radwaste discharge characteristics of the HTGR are compatible with the environmentally sensitive nature of the South Dade site that borders the Biscayne National Forest. Perhaps most important is the fact that the South Dade site is within about 30 miles of downtown Miami and within about 12 miles of the city of Homestead. With the stringent regulatory and public acceptance demands, it is doubtful whether we could license that site today for anything but a HTGR. A siting evaluation has been conducted that has quantified and confirmed the HTGR siting advantages for the South Dade site.

During the past year, FP&L has actively participated with GCRA in the definition of the conditions under which a utility could build the HTGR Lead Plant. Perhaps most important, there has to be financial stability involved throughout the entire Project. You cannot start out to build a HTGR Lead Plant and then cancel it or indefinitely suspend it for financial reasons. That would not benefit the technology, and it would not help the industry. Therefore, the utility or project entity that builds the Lead Plant must have the financial wherewithal to see the Project through and it has to be a stable situation from the very beginning. This may mean that a utility has to get pre-approval from the regulatory agencies for such things as construction work in progress to be included in the rate base or develop innovative approaches to financing nuclear plants. It certainly means that there has to be continued support from the Congress and stable support within the Administration for the front-end technical and licensing development activities.

The second issue is licensability. The Nuclear Regulatory Commission's policy on licensing the HTGR must be explicit and consistent with the inherent safety features associated with that technology. Arbitrarily forcing the HTGR into the light water reactor mold in the standard safety review plan is simply inappropriate and counterproductive. Significant progress has been achieved during the past two years in this area. Finally, there must be prudent financial arrangements between the buyer and the seller that assure an appropriate incentive for each party in a successful Project. In particular, the vendor/suppliers must share the risks of the Project through firm prices and performance warranties that are consistent with commercial alternatives. Through GCRA, the Lead Project Strategy Plan has been developed as a framework for such cost and risk sharing arrangements. This plan indicates that the private sector intends to finance an amount equivalent to the "commercial value" of the Lead Plant and that this could be as much as 75% of the total Lead Project costs. I believe this is an important precedent with respect to large-scale demonstration projects.

In closing, I would like to comment on the Administration's failure to include funding for the HTGR Program in its FY 1984 budget request to Congress, and the importance of preserving and advancing the HTGR option. The Administration's failure to provide budget support for the HTGR has created an element of instability in the Program that inhibits the ability of GCRA and other Program participants from establishing a coherent Lead Project initiative. The HTGR possesses unique operating and safety characteristics that make it a valuable power generation option not only to FP&L, but also to the Nation. In this regard I urge Congress to continue support for the HTGR Program in FY 1984. Congressional budget support is vital to advance the Lead Plant technical and licensing development that is required for the Lead Project intiative. Thank you for the opportunity to present Florida Power and Light's interest in the HTGR.

Mr. Hall. Mr. Uhrig, thank you very much.

We can go into questions, not necessarily in the order of your testimony. We might begin, though, with Mr. Walker by asking you what high-temperature gas-cooled reactor benefits do you believe are now being exhibited at Fort St. Vrain?

Mr. R. F. Walker. We certainly have demonstrated the technology at the 330-megawatts electrical size, which is comparable to the size of coal-fired plants that we have in our region. The prestressed reactor concrete vessel has performed in excellent fashion. We have had no trouble whatsoever with that. The steam generators, except for two very minor leaks since 1976, have performed up to our expectations. The fuel has performed particularly well, with the circulating radiation level in the helium being about 2 percent of the design level.

All of that leads to a very low exposure rate for our workers. We have experienced orders of magnitude-less exposure to our workers than conventional reactor systems. In fact, in 1982, of the 1,000 people that were badged through the plant, only 22 of those badges showed any measurable exposure at all. Further, all workers at the plant have access to the containment region of the plant.

Like any new plant, though, we have had problems with certain systems. For example, we have had some difficulties with the helium circulator auxiliary systems. We have spent a considerable amount of money to change the auxiliary systems, and we still need to do some development work, particularly on the circulator seals. This is one of the areas being investigated in the development program and we are very pleased with it.

I can go on. The fuel handling has been good, except for some minor computer control problems. But we would not build another plant, I would say in all candor, the way we built this plant. You do not build demonstration plants like this and then repeat them. You build them to learn. It is a little ironic that at Peach Bottom, where I happened to work on the design, we went with electric motor drives for the helium circulators. We changed over to steam drives in the Fort St. Vrain plant. We have now decided that electric drives are better, and the lead plant will use electric drives.

At Fort St. Vrain, we decided that reheat was worth the extra dollars for increased efficiency. Since that adds considerable complications to the plant design, we have eliminated reheat and reduced the temperatures slightly in the lead plant. So we are using the experience we have from Fort St. Vrain and we do have this window to do that. As Dr. Richards and I think Dr. Uhrig both pointed out, there is no substitute for having many of these problems and including the experience in a good engineering design before you actually get in the field and start to build. Overall we are very pleased with Fort St. Vrain. It has been a very good experience for the HTGR program.

Mr. Hall. Concerning the level of funding, did I understand you to say that for 1984, a level of $40 million would be necessary for continuing the program?

Mr. R. F. Walker. About $40 million, yes, sir.

Mr. Hall. But you feel the needs are closer to the area of $60 million?

Mr. R. F. **Walker**. Yes; If we were going to a more optimum expenditure of money to fit in with our schedule, it would call for about $60 million. What that does is really delay a little bit the time that the plant would come on line. But certainly the $39 or $40 million would keep the program going in a stable fashion.

Mr. **Hall**. Are there other questions? The gentleman from Washington?

Mr. **Chandler**. No questions.

Mr. **Hall**. Dr. Agnew, is GA Technologies committed to the HTGR?

Mr. **Agnew**. Absolutely.

Mr. **Hall**. What comments do you have on the ability of the HTGR to prevent water ingress into the helium coolant and reactor?

Mr. **Agnew**. I think, as referenced by Mr. Walker, there have been problems with regard to the water bearing seals and circulators. Primarily, this is brought about by the auxiliaries. These are the systems that provide the buffer heating and keep the water ingress out. The progress is first to complete the redesign of those seals, but perhaps more importantly a redesigning of the auxiliaries so that the auxiliaries are matched to the individual bearings. The present system essentially had one system that had to take care of all the bearings; When there was a glitch in part of the system, the rest of the system suffered.

In addition, at the Fort St. Vrain plant, the seals and the bearings and the auxiliaries were not totally tested beforehand as a complete system. In the new plant, the total system would be tested ahead of time. I think that is the point Mr. Walker mentioned. As an engineer, he appreciates it is better to test your system before you put them on and hope that your design and the paperwork is correct. We will fully test the system.

In addition, the helium cleanup system will be increased by a factor of 10 in its ability to remove low levels of water. The advantage of that is when there are down times and some atmospheric water has ingressed, you take the top off or something, and you will be much quicker in getting the plant down to the levels. Also in ameliorating the effects of water, we expect better graphites to be available, which will be perhaps as much as 1,000 times more resistant to the deleterious effects of the ingress of water.

Mr. **Hall**. Either Mr. Richards or Mr. Uhrig have alluded to the need for political support. What are the facts with regard to whether or not you are getting political support? You did not conduct a march here yesterday, did you?

Mr. **Uhrig**. This committee in particular has been very supportive of the HTGR, and we would hope that this would continue on a long-term basis. We feel that long-term support is essential. Stability is the critical item, because when you get into building a plant, it involves a 7-to 10-year commitment of funds before you finally see that plant coming on line.

Mr. **Hall**. What advantages does Florida Power & Light see for nuclear power when you look ahead?

Mr. **Uhrig**. In this particular case, it is the only reasonable option at that particular site, which is the only site that we have close in to our major load centers. Being close in cuts down transmission losses. It also increases reliability, both of which we consider to be very important.

Mr. **Hall**. Mr. Uhrig, you testified that your unit II is nearing completion?

Mr. **Uhrig**. Unit II at St. Lucie is essentially completed now. It is in the checkout phase. Our fuel load date is tentatively set for March 23, with some indication fuel loading that may slip a few days.

Mr. **Hall**. When do you see a need for constructing the next major powerplant, and what type of plant do you feel that would be?

Mr. **Uhrig**. We have two coal plants that were started and are presently being held in abeyance. They are now scheduled for, I believe, 1991 and 1993. There is some indication that with the availability of excess coal power from the Southern Co., we may further delay those units. An alternative may be to cancel those and to build an HTGR if this is the way we elect to go.

We are also presently involved in a joint project with Jacksonville Electric Authority for two coal units that will come on line, I believe, in 1986 or thereabout. We will not need additional capacity beyond what is planned until the midnineties.

Mr. **Hall**. What are your reasons for selecting an HTGR and what would be some of the arguments for selecting it?

Mr. **Uhrig**. The major reason for selecting an HTGR for this particular site is simply its desirable siting characteristics; i.e., its inherent safety characteristics, its benign environmental effects, and the reduction in the amount of water that is required. Water is a very critical item in that particular area. Biscayne Bay is shallow and not appropriate for open-ocean cooling. The plants that we have there presently use cooling canals. Any future plants would probably use cooling towers with makeup water being pumped out of the Floridan aquifer. At least that was the tentative plan.

An alternative may be tertiary treated water from a sewer plant, that is scheduled to be built in that time frame.

Mr. **Hall**. A more general question I would direct to any of you. You cannot turn on the television or pick up the paper without seeing some reference to a march or to a protest against nuclear power. What effect does that have on the morale of the people who work for you and make the wheels turn?

Mr. R. F. **Walker**. Let me answer first. We have an operating nuclear plant. We found the people in the area of our plant very supportive of our people, the local towns and newspapers. There was a kind of interesting incident when we had to pass out the radios for emergency control. We had several people who did not even want to take them. They said, "We don't want them." We kept telling them, "You have to take them. It is part of the plan." They feel very comfortable with it, and we have had no major protests at our nuclear plant. Four or five years ago, we had 30 or 40 people show up, and the protest, as far as I am concerned, was a complete bust and we have had none since then. So our relationships with our plant and its characteristics have been very good, with public acceptance.

Bob, you can speak about St. Lucie or Turkey Point.

Mr. **Uhrig**. The workers in those plants are very dedicated to the nuclear power field. They feel very strongly that the plants are safe, that nuclear power is the best way to go. We have had relatively little public objection.

Mr. **Hall**. Being personally very pronuclear myself, I have noticed though, in speaking to high schools and universities, that there is a thrust to cause them to be anti. What is the industry doing in the field of education or in the field of trying to reach these youngsters to impress upon them the need for additional energy? Once this is impressed upon them, even in a group where I have had a show of hands, when I talk to them about energy being the cause of wars, and if you remove the cause of wars by supplying energy, they have a change of mind. What is the industry doing to get that point over to them, that if we could solve the nuclear problem, clean up Three Mile Island, remove the problems that confront us, for those youngsters that hold up the sign out there that say, "No Nukes," that same sign might say, "No Wars." How do you get that over to them? Is the industry trying to do that?

Mr. R. F. **Walker**. There are industry programs. There is the energy awareness program of the utilities and associated industries that is attacking this on an overall, nationwide basis. It ultimately would cover various kinds of energy, but they are focusing on nuclear now. The main emphasis has been in Chicago and the Phoenix area. I think it is a little early to tell whether that program is really achieving anything.

Mr. **Hall**. Is that a pilot program?

Mr. R. F. **Walker**. No, it is a $25 or $30 million program. I think, more importantly, all of us in our own areas need to work at the grassroots level. In our company we have a group of people called "The Communicators," some 200 of our company employees. We actually go out to schools and clubs, and at every opportunity we train these people to be speakers. They not only talk about nuclear; they talk about all energy issues. There are a lot of other problems out there, not the least of which is the level of rates. But I think you have to get out to smaller groups. I think the media is a good way of doing it, but you cannot get to the grassroots thing. Work in your churches, work in your schools, and really get to these people. Tell them how important energy is and some of the advantages it really does have. It is a tough problem, Congressman, it really is.

Mr. **Hall**. Get over to them that France and England live off of it.

Mr. R. F. **Walker**. But it is tough to get across to them.

Mr. **Hall**. I just wonder sometimes if you are really trying hard enough to get it over to them. Some of us feel that we are biting the bullet without too much help from industry.

Mr. R. F. **Walker**. Certainly as CEO of our company, I emphasize this getting out and working with the people. That is where you have to do it, and we all have to do it at our local level. We cannot rely on an overall media program nationwide. We need that, maybe, but we also need the local input. Work with your newspapers, work with science teachers, and those kinds of things.

Mr. **Hall**. The gentleman from Washington?

Mr. **Chandler**. You sparked a question that I would like to follow up on, too. In addition to that, I just left a discussion with

John Ellis who, I am sure you gentlemen are aware of, is the president of Puget Power. We were talking about the problem of getting people to understand that these other alternatives to nuclear that we so often hear about, including conservation, which seems to be free, have a very definite cost and very often a cost where the margin is vastly more expensive than additional generating capacity, including nuclear energy.

Are you finding that in Florida? Do you find that in California? Is this just a Pacific Northwest phenomenon? It seems too easy to say, "Let's not build anything more. Let's just conserve," as if that was a free option that did not cost anything.

Mr. **Uhrig**. We have a very aggressive conservation program, basically required by the Public Service Commission, but we probably would have had a similar program even if it had not been required. However, you can only do so much in conservation. You can only turn the temperature down once. You can turn it from 75 to 70. Maybe you can get it to 65, but you cannot turn it to 60 or 50 in the wintertime. The same goes with air-conditioning. You can cut it out to a certain extent, but there is a limit to what you can do in conservation.

There may be other techniques to reduce the need for additional capacity, particularly load control. We are experimenting extensively with load control. When we get near our capacity limit, we turn off hot water heaters and air-conditioning. This has been partially successful in reducing peak loads. Ultimately you have to face the fact that you have to have more generating capacity. You just have to plan for it and to build it when you need it. The problems are where and when.

Mr. R. F. **Walker**. Let me address the situation in Colorado, which is probably a little bit different than other parts of the country. We are affected by the recession, but we still have customer growth in the 2½- to 3-percent range of new people coming to our area. Also, with our favorable climate, we do use air conditioning but not nearly like you do in Florida. We have very little electric heat; we are a combination company, and most of our people use natural gas.

As a consequence, our electric use per customer is very low. In fact, there are only about nine utilities in the United States that have a lower use per customer in an electric residential customer. So there is not very much there. So I do not anticipate any reduction in the amount each individual customer is going to use. With more customers, we look for that growth to go on.

On the gas side of our business, that has not been true. We have had a sevenfold increase in the price of gas in 10 years, and that has reduced consumption by 30 percent. That is just plain dollars and cents. You just do not do that to people without expecting them to use less of the product. I think some of that has leveled off, but we have been hurt on the gas side. On the electric side, conservation has had some impact. Some of that is good. In the commercial sector, stores have done a better job, particularly grocery stores in locating their vegetables, meat, air doors and that type of thing, they have cut down. We encourage that. I think that is just good business sense and makes our area competitive. But in our case, on the electric side, there can be some more reduction in electric but not to a great extent.

So, with our customer growth and that low usage, we do project that we will continue to grow on the electric side. This conservation will not be a great factor on our electric side.

Dr. **Agnew**. There is another aspect of conservation. Take the heavy crudes on the North Slope. ARCO has some major holdings there. In order to get those crudes up, they will be burning between 30 and 40 percent of the materials they bring up to generate the steam in order to reduce the viscosity of that crude to get them up. I am very much in support of the future that Dr. Richards talked about. It happens to the HTGR. It is the only reactor that operates at high enough temperatures to get high enough pressure steam so that you can inject it and get those crudes up.

That, to me, is a form of conservation. You are going to waste, in a sense, half of that oil just to get it above ground, and this is happening throughout the country. And of course by burning it, you are increasing the carbon dioxide levels. So I think there are many aspects of conservation where nuclear energy really can play a major role in conservation.

Mr. **Chandler**. I really appreciate your comment. The point I was driving at is, I can see our situation is somewhat different than yours in Colorado and obviously different from Florida. What I think we have allowed ourselves to do is to be talked into the notion that you can have built into the utilities rate base a security blanket, a security program to retrofit homes, which pays for nearly all the cost of putting in additional windows and insulation and all that business. It appears free. People think they are getting this for nothing.

Dr. **Agnew**. They are paying for it out of their taxes.

Mr. **Chandler**. Actually, out of their utility rates.

Dr. **Agnew**. But they are paying for it out of their taxes, too, because they get a tax rebate. There is only a certain amount of money. So if you want to pay $2,000 for a hot water heater, you probably should do it, because if you do not somebody else will and you are going to pay for his. Way down deep, it is a dumb thing.

Mr. **Hall**. We have a hard time believing it is free.

We thank you, gentlemen, for your very excellent testimony.

Our next panel of two witnesses on the Light Water Reactor Fuel Burnup program will be led by Dr. William M. Jacobi of Westinghouse, followed by Dr. Charles W. Pryor from the Babcock & Wilcox Co. Gentlemen, we do welcome you here today. Dr. Jacobi, if you would like to begin, you might summarize your statement or proceed as you wish. Your written statements will be made a part of the record.

STATEMENT OF WILLIAM M. JACOBI, GENERAL MANAGER, NUCLEAR FUEL DIVISION, WESTINGHOUSE ELECTRIC CORP., PITTSBURGH, PA.

Dr. **Jacobi**. Thank you. I will try and summarize the quantitative points for you. Mr. Chairman, I am William Jacobi. I am general manager of the Nuclear Fuel Division of Westinghouse Electric Corp. As a major manufacturer of high-performance fuel for the nuclear industry, I am grateful for the opportunity to appear before your committee and to provide our views on extended fuel burnup.

Before going into the points that were raised in the letter of invitation, I would like to first review some of the benefits that we receive from extended fuel burnup. The principal benefit that we see from implementing extended fuel burnup is a major reduction in the quantity of spent fuel which must be first stored by the utilities and then, second, later be disposed of by the Government under the provisions of the Nuclear Waste Policy Act.

Exactly how much benefit we get from this is sensitive to the rate, the timing, and the adoption of fuel burnup increases in nuclear plants. But if we assume that the DOE's goal of 50,000 megawatt-days per metric ton of uranium [MWD/MTU] could be introduced in 1990, we would see a reduction of about 12,000 metric tons of spent fuel discharged through the year 2000. That reduction, just in that decade alone, would represent a saving of over $2 billion in spent fuel transportation and disposal costs, based on DOE's waste management planning information.

Continuous operation at that 50,000-MWD/MTU burnup level would represent a 35-percent reduction in the quantity of spent fuel discharged annually, and it would provide room for a very significant improvement in the funding requirements of the waste disposal program.

The effect of this burnup increase on a utility's fuel cycle cost is also going to be improved. Exactly how much will depend upon what the utility's spent fuel storage capability is to handle fuel as it is discharged. We would foresee a minimum reduction in fuel cycle costs of 1 percent if the utility had more than adequate spent fuel storage capability. If the utility has to increase its storage capability through reracking or even additional fuel pool construction, the benefit could be as much as 5 percent in the fuel cycle cost.

Another factor that I would like to mention is the growing trend in the utility industry for longer fuel cycles. It used to be that a 12-month cycle was standard; That is rapidly increasing to 18 months or longer. You can achieve that at present burnup levels simply by introducing more new assemblies at each cycle, but the fuel management and the flexibility of operation is certainly significantly greater if you have higher burnup fuel. Of course, if you have a longer fuel cycle, that reduces the number of days of downtime, gives you better availability, and lowers replacement power costs.

The utilities, of course, fully recognize the benefits to them and their ratepayers of extended fuel burnup. Their interest in going to higher burnup fuel management is constrained by the need to maintain a high availability of their units and to maintain low levels of radioactivity in their primary coolant. To the extent that fuel failures occur, they increase the man rem of exposure to the workmen in the plant, they complicate the maintenance and refuelling operation. They may cause longer outages, and in general that is a very expensive and undesirable thing.

The fuel industry has established a very excellent record of operating reliability, as measured by primary coolant radioactivity, and we continue to put very substantial portions of our own funds into trying to achieve further improvements. But any product design change, including increases in burnup, has to be extensively analyzed, tested, and verified in operating reactors before such a product improvement is judged acceptable by the buying utility.

We have emphasized new product development at Westinghouse, and I might mention that just late last year, we began delivery of the first core loading of our new optimized fuel assembly. That incorporates about a 10-percent burnup increase to 36,000 MWD/MTU. But the cycle to get there was quite a long one. Earlier, in the midseventies, we were in the lower 30,000 MWD/MTU region. The design work on optimized fuel started in 1975. In deciding to offer this increased burnup on a standard commercial basis, we took into consideration the successful in-reactor performance of over a million fuel rods, together with a data base of test fuel rods which were examined in hot cells after burnup levels as high as 50,000 MWD/MTU.

The point of this is just to underscore the fact that each new change, including burnup increases, has to be predicated on fuel performance data that is specific to the fuel supplier and to the product type. What is succesful for one fuel design might not necessarily be successful for a different one. And the utilities have generally required us to use a very rigorous approach to product qualifications before they put it in their reactors, and I think that has been prudent on their part.

Looking at what those verification requirements are, I would anticipate that continued increases in operating burnup level will occur, but they will be paced by a combination of both successful reactor operating experience and also the availability of very high burnup test results that have been verified by hot cell examinations. These are the examinations that are, today, partially supported by the current DOE-utility-vendor projects. Neither the operating utilities nor the fuel suppliers can afford the economic risks operating fuel to inadequately-verified burnup levels.

We see DOE's continuing role in supporting the extended burnup program, including new contracting authority, to be very readily justified on the basis of the large savings in spent fuel waste disposal that will be realized by the Federal Government through increasing burnup levels to the 45,000 or 50,000-MWD/MTU range. We think the cost-effectiveness is extremely high because you are talking about billion-dollar benefits, relative to a $10 million level for continuing a program.

If DOE's program is not sustained, the schedule for realizing full benefits of extended burnup is likely to be lengthened considerably. The DOE project funding has permitted very extensive destructive examination in hot cells, an activity that we have not normally been able to support under privately funded projects. If we had an industry-only supported program, it would more likely rely on nondestructive examination of larger quantities of test fuel at reactor sites, carried out over a longer number of reactor operating cycles. I think the natural consequence would be to delay the time within which you would see a full commercial implementation of extended fuel burnup.

In summary, we think DOE's extended program will lead directly to significant reductions in waste management costs and appreciable uranium conservation. The continued pursuit of the extended burnup program with five fuel vendors will provide major cost-savings to both the nuclear waste fund and to utility ratepayers. We would strongly recommend that the program be continued at the $12 million level in fiscal year 1984 and that steps be taken to maintain the continuity of the fiscal year 1983 program with full industry participation.

Thank you, Mr. Chairman.

[The prepared statement of Dr. Jacobi follows:]

PREPARED STATEMENT OF WILLIAM M. JACOBI, GENERAL MANAGER, WESTINGHOUSE NUCLEAR FUEL DIVISION

Madame Chairman and Subcommittee members, I am William M. Jacobi, General Manager of the Westinghouse Nuclear Fuel Division. As a leading manufacturer of high performance fuel for the nuclear industry, I am grateful for this opportunity to appear before your Committee and provide my views on extended fuel burnup, as you requested.

Before addressing the points raised in your letter of invitation, it is appropriate to review the benefits of extended burnup which will accrue to the Federal Government and to the operating utilities and ultimately their rate payers. The principal benefit of implementing extended fuel burnup will be to make a major reduction in the quantity of spent fuel which must first be stored by the utilities and later disposed of by the Federal Government under the provisions of the Nuclear Waste Policy Act of 1983. The exact determination of this saving in fuel storage and disposal requirements is sensitive to the rate, timing, and adoption of fuel burnup increases in nuclear power plants. Assuming that the DOE PWR goal burnup of 50,000 MWD/MTU could be introduced in 1990, a reduction of about 12,000 metric tons of spent fuel discharged through the year 2000 will be realized. This reduction in spent fuel volume would represent a saving of over 2 billion dollars in spent fuel transportation and disposal costs based on DOE waste management planning information. Continuous operation at the 50,000 MWD/MTU burnup level represents a 35% reduction in the quantity of spent fuel discharged annually, and therefore provides an opportunity for a very significant improvement in the funding requirements of the waste disposal program. Therefore a modest investment in this DOE program on extended burnup will result in considerable benefits to the program which DOE is now implementing under the landmark nuclear waste legislation sponsored so effectively by your subcommittee.

The effect of this level of burnup increase on the utility's fuel cycle cost will vary considerably with fuel storage capability. A fuel cost reduction in the range of 1 to 5 percent can be realized depending on the cost of providing additional storage facilities. A significant factor contributing to the improvement in fuel cycle cost is the reduction in uranium resource consumption, which can reach 15 percent at the 50,000 MWD/MTU burnup level with the best fuel management and core design techniques.

Although reactor operating cycle length can be increased without changing fuel burnup simply by increasing the number of fuel assemblies loaded, increased burnup facilitates increasing cycle length from 12 to 18 months and this contributes to reductions in power generation cost which derive from the improvement in reactor availability.

The operational and economic benefits of extended fuel burnup are well recognized by the utilities and these benefits are a major reason for the existing cooperative program. However, their interest in implementing higher burnup fuel management is constrained by the need to maintain high nuclear generating unit availability and to maintain very low levels of radioactivity in the reactor primary coolant, usually a small fraction of the Nuclear Regulatory Commission Technical Specification limits. The complications that arise in normal operation and maintenance procedures when increases in coolant activity are experienced can result in significant increases in operating expense and can also increase the length of refueling outages when more expensive fossil generated replacement power must be used. The nuclear fuel industry has established an excellent record of operating reliability as measured by primary coolant activity and we continue to commit a significant portion of our research and development funds to programs which are directed towards further improvements in fuel reliability. Very low fuel rod defect levels are required to maintain acceptable coolant activity levels. Any product design change, including increases in fuel burnup, must be extensively analyzed, tested, and verified through prototype use in operating reactors before such a product improvement can be evaluated and judged acceptable by the potential buying utility. Westinghouse has emphasized new product development, and the delivery of our first reload region of our new Optimized Fuel Assembly product line this year includes a ten percent burnup increase to 36,000 MWD/MTU. I should point out that the time required to complete this type of product improvement is very long. The work to increase the burnup to 36,000 MWD/MTU from 33,000 MWD/MTU was initiated in the mid-1970's.

In deciding to offer this increased burnup on a standard commercial basis we took into consideration the successful in-reactor performance of over a million fuel rods together with an extensive data base of test fuel operated to burnup levels as high as 50,000 MWD/MTU. The point of this review of our product development effort is to underscore the fact that each major fuel product design change, including increases in burnup level, must be predicated on extensive fuel performance data which is specific to the fuel supplier and product type. The utilities, in their pursuit of high fuel operating reliability, require that this rigorous approach to product qualification be demonstrated to their satisfaction.

In view of the extensive performance verification requirements necessary to support commercial deployment of extended fuel burnup, I anticipate that continued increases in operating burnup levels will primarily be paced by a combination of continued successful reactor operating experience with our new fuel products and the availability of very high burnup test results verified by detailed hot cell examinations. These examinations are partially supported under current DOE-utility-vendor projects. Neither the operating utilities nor the fuel suppliers can afford the economic risks of operating fuel to inadequately verified burnup levels.

The continuing role of DOE in supporting a full scope extended burnup performance demonstration program, including new contracting authority, is readily justified on the basis of the large savings in spent fuel waste disposal operating cost which will be realized by the Federal Government through increasing fuel burnup levels to the 45,000 to 50,000 MWD/MTU level. The cost effectiveness of this activity is extremely high, since billion dollar benefits can be realized in waste disposal for only ten million dollar levels of continued burnup program support.

Without sustained DOE program support, the schedule for realizing the full benefits of extended burnup is likely to be lengthened considerably. DOE project funding has permitted very extensive destructive hot cell evaluation of test fuel, an activity which has not normally been affordable under privately funded projects. An industry-only supported program will more likely have to rely on non-destructive examination of larger quantities of test fuel rods at the reactor sites, carried out over a longer number of reactor operating cycles. This will naturally delay the time at which full commercial implementation of extended fuel burnup can be realized by the operating utilities.

In summary, the DOE Extended Burnup Program can lead directly to significant reductions in waste management costs and appreciable uranium conservation. The continued pursuit of the Extended Burnup Program with five fuel vendors will provide major cost savings to both the Nuclear Waste Fund and to utility ratepayers. We strongly recommend this program be continued at the 12 million dollar level for Fiscal 1984 and that steps be taken to maintain the continuity in the Fiscal 1983 program with full industry participation.

BIOGRAPHICAL DATA ON W. M. JACOBI

Dr. William M. Jacobi joined Westinghouse in 1955 after earning a Ph. D. in Chemical Engineering at Syracuse University, Syracuse, New York. He has also done graduate work in Chemical Engineering at the University of Delaware, Newark, Delaware. Dr. Jacobi joined Westinghouse at the Bettis Atomic Power Laboratory in 1955, where he did heat transfer analysis on the Nautilus and Nautilus prototype reactor cores. He later worked on the nuclear design of naval reactors, and in 1958 was a scientist in charge of the S5W nuclear design. In 1960, he was supervisor of the A1W Core 3 nuclear design. In 1961 and 1962, he joined the Nuclear Utility Services Corporation where he did general consulting work on commercial nuclear power plants. In 1963, he rejoined Westinghouse at the Astronuclear Laboratory, where he was Manager of Advanced Reactor Design for the NRX-A6 and the NERVA II reactors. In 1968, he transferred to the Weapons Department at Baltimore on the MK 48 Torpedo Program where he was Manager of MK 48 Design Engineering, and later Manager of MK 48/27 Follow-On Programs. He joined the Advanced Reactors Division in September, 1970, and served as Engineering Manager on the Fast Flux Test Facility. He was Project Manager for the Clinch River Breeder Reactor Plant from 1973 to 1977. In 1978, he became Manager of Systems Engineering in PWR Systems Division at Monroeville Nuclear Center. In 1979, he became General Manager for Nuclear Technology Division. In 1981, he became General Manager for Nuclear Fuel Division.

Mr. HALL. Thank you, Dr. Jacobi.

Dr. Pryor, you might summarize, if you would like, or stay with your text. But in either instance, your written statement will go into the record.

STATEMENT OF DR. CHARLES W. PRYOR, JR., MANAGER, NUCLEAR FUEL SERVICES DEPARTMENT, BABCOCK & WILCOX CO., LYNCHBURG, VA., ACCOMPANIED BY J. BARCLAY ANDREWS II, MANAGER, FUEL ENGINEERING, NUCLEAR FUEL SERVICES, BABCOCK & WILCOX CO.

Dr. PRYOR. Thank you, Mr. Chairman. In the interest of time, I will try to summarize the text here.

I am Charles W. Pryor, Jr., manager of Babcock & Wilcox' commercial nuclear fuel business segment. My business segment is responsible for the design, licensing, and fabrication of nuclear fuel for operating nuclear pressurized water reactors. I have with me here today to assist in any questions the committee members may have Dr. Barclay Andrews, who is manager of our fuel engineering section.

We appreciate the opportunity to testify in support of the light water reactor extended burnup program before your committee. In the testimony today, I will initially address the objectives and benefits of the program and then discuss what I believe are key issues that the subcommittee must consider as it decides on the appropriate congressional position regarding the future of the program. Specifically, I will address what has been accomplished and what remains to be accomplished in the program, reasons for continued funding by the Federal Government, and the need for involvement of multiple fuel vendors.

As noted previously in the testimony of others, in 1981 and 1982, the principal motivation for initiating the LWR extended burnup program, originally referred to as the uranium utilization improvement program, was to provide a means of conserving uranium resources and maintaining the viability of light water reactors as an energy option. This was in response to the decision to defer indefinitely spent fuel reprocessing. The goals of extending the batch average burnup of LWR fuel to 50,000 MWD/MTU for pressurized water reactors and 45,000 MWD/MTU for boiling water reactors were endorsed by the nuclear community as evidenced by the establishment of various utility fuel vendor programs.

Today, an equally strong national need for the LWR extended burnup program exists, in addition to uranium utilization improvement, and that is the need to reduce the generation of spent fuel and lower future spent fuel storage requirements. However, the benefits to be obtained are dependent upon the timely completion of the extended burnup program goals as currently planned.

The benefits of extended burnup have been widely recognized and endorsed by the technical community. These benefits are very substantial, and it is estimated by a 1981 Government Accounting Office study, the completed LWR extended burnup program will save the electric ratepaying public at least $12.7 billion before the year 2000, a savings of $385 for each dollar spent in the program.

These benefits accrue from the reduction of spent fuel generation by approximately 40 percent, yellowcake requirements by 15 percent, enrichment requirements by 2 percent, and the reduced replacement power cost associated with reactor availability improvement. In addition to these specific and quantified economic benefits, positive synergistic effect on the overall fuel cycle and reactor safety is also anticipated.

The LWR extended burnup program has been and will continue to be one of the biggest success stories for Government and private-sector cooperation, benefiting the Nation and the general public. Each of the fuel vendors has already contributed up-front technology by disseminating to the public proprietary information on fuel performance that was gained at the cost of millions of dollars to the fuel vendors. Furthermore, contributions by both the vendors and the utilities, in terms of the time and support from their staffs and the sharing of new technology, have continued.

The first stages of commercialization of extended burnup are in place now. Babcock & Wilcox is offering fuel cycle designs, featuring batch average burnups about 20 percent greater than those conventionally used in our design reactor. Upon successful completion of our existing program, the goal of 50,000 MWD/MTU will be offered. Similar efforts are underway by all the fuel vendors, as evidenced by the submittal of topical reports to the Nuclear Regulatory Commission. An informal survey of utility fuel cycle plans has indicated that about two-thirds of the LWR owners have made the decision to move to higher burnups. However, these plans are undoubtedly predicated upon the timely and successful completion of the LWR extended burnup program.

Several of the fuel vendor utility teams have completed lead test assembly irradiations to burnups of about 50,000 MWD/MTU. Examination of this fuel and analyses of the data are now in progress. The data collected to date have confirmed the basic capability of the fuel to achieve the program goals of 50,000 and 45,000 MWD/MTU for PWR's and BWR's, respectively. However, the data has also shown that design changes are required in some cases and highly desirable in others. Designs incorporating the required and desired changes must be tested to verify their performance.

The known major technical issues remaining to be addressed are: fission gas release, cladding waterside corrosion, pellet-cladding interaction, and improved burnable poisons. A large data base on fuel performance as a function of burnup must also be collected to insure that the currently very high level of performance integrity for the fuel is maintained and that there are no unidentified phenomena that might limit fuel lifetime.

The Federal Government should continue to fund the extended burnup program because sufficient incentives do not exist in the private sector to provide for the timely implementation of extended burnup and, thus, realization of its full benefits. For fuel vendors, increasing fuel burnup lowers the number of fuel assemblies required to fuel a reactor. Thus, it reduces our manufacturing throughput, raises the unit cost, and reduces our revenue. This, coupled with the fact that there is already excess capacity in the fuel supply business, is a disincentive for the fuel vendors.

Furthermore, extending the lifetime of the fuel assembly increases warranty risk. Thus far, extended burnup fuel has demonstrated integrity and performance capabilities comparable to lower burnup fuel. However, sufficient technology does not exist today to justify accepting the financial risk associated with greater warranties on all fuel. The combination of these factors can make the offering of extended burnup not in the best business interest of the vendors, since large research and development investments are required to justify the use of extended burnup. I do not believe the utility/vendor teams that are now in place today would complete their programs as presently planned if the Government withdraws its support.

Attempts to directly market extended burnup development programs to utilities have generally been unsuccessful. Nearly 85 percent of the State public utility commissions require utilities to pass their fuel efficiency savings directly to the ratepaying public. Furthermore, utilities have been severely burdened by cash flow problems, and when money is available it is usually used for availability improvements first.

On the question of how many fuel vendors should be funded, I believe that a one-vendor concept would provide a competitive advantage to that selected vendor. It would reduce his dollar investment in the technology, while giving him a potentially superior product. Also, I do not believe that the vendor/utility team program should be closed out, as currently planned. There are differences in reactor design, in fuel design, in reactor operating conditions for any one-vendor program to satisfy the needs of all. An equitable approach would be to assure that each vendor develops the same level of capability for commercializing extended burnup fuel.

Additionally, specific development programs should be pursued that benefit the entire industry and provide basic data that are currently unavailable.

In summary, I firmly believe that the LWR extended burnup program will provide a significant benefit to the general public and to the nation as a whole. These benefits will only be obtained through Government support of the timely and complete accomplishment of the goal of the extended burnup program, including resolution of any identified impediments.

Babcock & Wilcox is proud to be a part of this national effort that directly lowers the energy cost paid by consumers. Our belief is that such programs can provide direct stimulation to the economy and direct employment in the private sector through the well-known relationship between electrical consumption and business growth. Thank you, sir.

[The prepared statement of Dr. Pryor follows:]

PREPARED STATEMENT OF DR. C. W. PRYOR, JR., BABCOCK & WILCOX, A MCDERMOTT CO.

Madam Chairman and members of the Subcommittee, I am Charles W. Pryor, Jr., Manager of the Nuclear Fuel Services Business Segment of Babcock & Wilcox's Utility Power Generation Division. We appreciate this opportunity to testify in support of the Light Water Reactor (LWR) Extended Burnup Program before the Subcommittee on Energy Research and Production of the House Science and Technology Committee. In my testimony today, I will initially address the objectives and benefits of the program and, then, discuss what I believe are key issues that this Subcommittee must consider as it decides on the appropriate Congressional position regarding the future of the program. Specifically, I will address what has been accomplished and what remains to be accomplished in the Program, reasons for continued funding by the Federal Government, and the need for involvement of multiple fuel vendors.

As noted in testimony by others② in 1981 and 1982, the principal motivation for initiating the LWR Extended Burnup Program, originally referred to as the Uranium Utilization Improvement Program, was to provide a means of conserving uranium resources and maintaining the viability of LWRs as an energy option in response to the decision to indefinitely defer spent fuel reprocessing. Studies by numerous experts concluded that the most effective near-term means of improving uranium utilization, under the no reprocessing scenario, was to extend the lifetime, or burnup, of the fuel. The goals of extending the batch average burnup of LWR fuel to 50,000 MWd/mtU for pressurized water reactors (PWRs) and 45,000 MWd/mtU for boiling water reactors (BWRs) were endorsed by the nuclear community as evidenced by the establishment of the various utility/fuel vendor programs.

Today, an equally strong national need for the LWR Extended Burnup Program exists in addition to the uranium utilization improvement - namely, the need to reduce the generation of spent fuel and lower future spent fuel storage requirements. In addition to conserving uranium resources and improving nuclear economics, extended burnup can roughly halve spent fuel generation during the next two decades, while a permanent disposal solution is put in place. However, the benefits to be obtained are dependent upon the timely completion of the Extended Burnup Program goals.

The benefits of extended burnup have been widely recognized and endorsed by the technical community. These benefits are very substantial, and, as estimated by a 1981 Government Accounting Office study, the completed LWR Extended Burnup Program will save the electric rate-paying public at least $12.7 billion before the year 2000, a savings of $385 for each dollar spent. These benefits accrue from the reduction of spent fuel generation by 40%, yellowcake (U_3O_8) requirements by 15%, enrichment requirements by 2%; and the reduced replacement power cost associated with reactor availability improvements. In addition to these quantified economic benefits, a positive synergistic effect on the overall fuel cycle and reactor safety is anticipated. The already small environmental effects of the nuclear fuel cycle are further decreased by the concommitant reduction in uranium mining and milling, conversion and enrichment services, fuel assembly fabrication, spent fuel storage, waste disposal, and transportation associated with extended burnup. Ancillary technology, such as low-leakage fuel management and an improved understanding of the pellet-cladding-interaction phenomenon resulting from the Extended Burnup Program, have proven important to reactor safety and operational issues.

The LWR Extended Burnup Program has been and will continue to be one of the biggest success stories for government and private sector co-operation, benefiting the nation and the general public. Each of the fuel vendors has already contributed "upfront" technology by disseminating to the public proprietary information on fuel performance that was gained at the cost of millions of dollars to the fuel vendors. Furthermore, contributions by both the vendors and the utilities in terms of the uncompensated time and support from their staffs and sharing of new technologies have continued.

The first stages of commercialization of extended burnup are in place. Babcock & Wilcox is offering fuel cycle designs featuring batch average burnups about 20% greater than those conventionally used in B&W-design reactors. Upon successful completion of our existing programs, burnups of 50,000 MWd/mtU will be offered. Similar efforts are underway by all of the fuel vendors as evidenced by submittals of topical reports to the NRC. An informal survey of utility fuel cycle plans has indicated that about two-thirds of the LWR owners have made the decision to move to higher burnups. However, these plans are undoubtedly predicated upon the timely and successful completion of the LWR Extended Burnup Program.

Several of the fuel vendor/utility teams have completed lead test assembly irradiations to burnups of about 50,000 MWd/mtU. Examinations of this fuel and analysis of the data from these exams are in progress. The data collected to date have confirmed the basic capability of the fuel to achieve the program goals of 50,000 and 45,000 MWd/mtU for PWRs and BWRs, respectively. However, the data have also shown that design changes are required in some cases and highly desirable in others. Designs incorporating the required and desired changes must be tested to verify their performance. The known major technical issues remaining to be addressed are: fission gas release, cladding waterside corrosion, dimensional and structural changes in the fuel with continued irradiation, pellet-cladding-interaction, and improved burnable poisons. A large data base on fuel performance as a function of burnup must also be collected to insure that the currently very high level of performance and integrity for the fuel is maintained and that there are no unidentified phenomena that might limit fuel lifetime.

Institutionally, the fundamental question is acceptance by the NRC and the utilities of extended burnup. The NRC has indicated support for the extended burnup programs predicated mainly on the belief that the current programs will demonstrate acceptable fuel performance at the higher burnup ranges. The utilities will accept extended burnup provided they do not judge the risks to outweigh the benefits. The Congress, by mandating a strong LWR Extended Burnup Program, can continue to build utility confidence and insure that the best interests of the nation and the public are served.

The federal government should continue to fund the Extended Burnup Program because sufficient incentives do not exist in the private sector to provide for the timely implementation of extended burnup and, thus, realization of its full benefits. For fuel vendors, increasing fuel burnup lowers the number of fuel assemblies required to fuel the reactor, thus reducing manufacturing throughput with the attendant unit cost increases and revenue reductions. This, coupled with the fact that there is excess capacity in the fuel supply business, creates disincentives for the fuel vendors. To remain a cost effective and viable fuel supplier in light of the low fuel volume, Babcock and Wilcox has had to phase out its Apollo, PA powder manufacturing facility. Many jobs have been lost due to the depressed fuel business environment.

Furthermore, extending the lifetime of the fuel assembly increases warranty risks. Thus far, extended burnup fuel has demonstrated integrity and performance capabilities comparable to or better than lower burnup fuel; however, sufficient technology does not exist today to justify accepting the major financial risks associated with greater warranties on all fuel. The combination of these factors can make the offering of extended burnup not in the best business interests of the vendors, since large R&D investments are required to justify the use of extended burnup. I do not believe the utility/vendor teams would complete their programs as presently planned if the government withdraws their support.

The country cannot rely only on market place pressures to commercialize extended burnup. Most fuel supply contracts are multi-year, long term contracts. Nearly 70 percent of the fuel contracts for the next twenty-five years are already in place and no new domestic Nuclear Steam Supply System sales are expected in the near future. Although the typical competitive forces in which one supplier seeks to gain market share through offering a superior product may surface in the long run, many substantial near term benefits to the public will be lost due to the long lead times before commercial offerings are realized. The LWR Extended Burnup Program is providing the impetus necessary to modify these long term contracts and begin the implementation of extended burnup now.

Attempts to directly market extended burnup development programs to utilities have generally been unsuccessful. Nearly 85 percent of the state public utility commissions require utilities to pass their fuel efficiency savings directly to the rate-paying public. Furthermore, utilities have been severely burdened by cash flow problems, and when money is available, it is usually directed toward availability improvements.

Ironically, the recent Waste Disposal legislation with a surcharge based on the amount of electricity generated, as opposed to the amount of waste generated, reduces the benefits of extended burnup for the utilities. In addition, the risks of higher operating costs due to potential fuel failures without proven extended burnup designs quickly overshadow the benefits of extended burnup when replacement power costs of as much as $650,000 per day for a modern PWR are considered. Thus, the principal beneficiaries of extended burnup are the general public and the nation as a whole, not the private sector.

On the question of how many fuel vendors should be funded, I believe that a "one vendor" concept would provide a competitive advantage to the selected vendor. It would reduce his dollar investment in the technology while giving him a potentially superior product. Also, I do not believe the vendor/utility team programs should be "closed out" as currently planned. There are too many differences in reactor design, reactor operating conditions, and the specifics of individual vendor fuel designs for any one vendor program to satisfy the needs of all. An equitable approach is to assure that each vendor develops the same level of capability for commercializing extended burnup fuel. Additionally, specific development programs should be pursued that benefit the entire industry and provide basic data that are currently unavailable. Examples of such specific programs are the international irradiation programs and the Gadolinia irradiation program currently underway at B&W, whose major goal is to provide fuel performance and nuclear performance data to the PWR industry.

In summary, I firmly believe that the LWR Extended Burnup Program will provide a significant benefit to the general public and to the nation as a whole. These benefits will only be obtained through government support of the timely and complete accomplishment of the goals of the Extended Burnup Program, including resolution of any identified impediments. Babcock & Wilcox is proud to be a part of this national effort that directly lowers the energy costs paid by consumers. Our belief is that such programs can provide direct stimulation of the economy and direct employment in the private sector through the well-known relationship between electrical consumption and business growth.

My colleagues and I will be most happy to answer any questions that you and the members of the committee may have.

Mr. HALL. Dr. Pryor, thank you. I think you pretty well laid out what you feel your company has accomplished today and what remains to be done.

Dr. Jacobi, do you have anything to add to that from the Westinghouse standpoint, as to where you have been and where you are going?

Dr. JACOBI. No. We have had a long-term program to improve the product. The utilities demand that. I am sure Mr. Pryor's company has done the same. Some of those changes come in response to changed economics. For example, the rapid increase in the price of uranium in the midseventies dictated new designs. I do not think we have seen the last of those kinds of changes. I think future requirements will require further design, and we will intend to do that development work.

Mr. HALL. Dr. Pryor, on page 2 of your testimony, you mentioned the potential $12.7 billion benefit to the public from extended burnup program. Dr. Jacobi I think also mentioned major savings to ratepayers. Here is the large profit motive, which is not bad, and apparently the large profit potential stems from a great demand. Will your company, as fuel vendors, be charging a premium for the higher burnup of fuel over current generation of fuel? And if the answer is yes, do either of you have an estimate of how much of the $12.7 billion would be reduced because of the premium charged by the vendors?

Dr. PRYOR. I am really not in a position to answer that now. We have not considered the marketing of extended burnup fuel at this point in time. As to whether or not we could command a premium for that, I am not in a position to answer that. But as I did mention to you, the actual amount of fuel that we would fabricate if we were in an extended burnup mode would be less than it is now.

Mr. HALL. You currently market higher burnup fuel, do you not?

Dr. PRYOR. We are marketing fuel burnups that are some percentage higher than we have in the past, but not at the level of the goals of this program.

Mr. **Hall**. Dr. Jacobi, do you have anything to add to that?

Dr. **Jacobi**. To the extent that the burnups increase significantly, I expect that we would ask a modest premium for that. There would be two reasons for that. One would be to recover some of the development costs. The other would be that we normally warrant the fuel for the full burnup, and the longer you are warranting it for, the more risk you have.

I would hasten to add that the effects on the ultimate ratepayer really would be peanuts. Fuel fabrication costs are roughly one-seventh of the total investment that a utility has in a new fuel assembly. That is, the utility's investment in uranium and enrichment services is six times, typically, of what our fabrication costs are. In addition, of course, you have to consider the cost of disposing it. So we are really a very small portion of the total fuel cycle costs.

Mr. **Hall**. This might sound like a loaded question, but both of you mentioned it. Your companies are already offering an improved fuel relative to burnup. Are both of your companies ahead of the other fuel vendors in offering higher burnup fuel, do you feel?

Dr. **Pryor**. There has not been a lot of competition lately for new fuel business. The fuel that is now fueling nuclear reactors is under contract. I am not in a position to say whether we are at an advantage or not.

Mr. **Hall**. You know Satchel Paige, the old baseball player, said, "Don't look back. He may be gaining." I wonder, if so, why do you want the program continued if it will benefit your competitors?

Dr. **Pryor**. I think what we are saying is, if the program continues, we believe it should continue with the five fuel vendor/utility teams that are in place. We stated that the reason for that is not to put one in a competitive position over the other.

Dr. **Jacobi**. I would like to comment just a little bit on your first question. I foresee that the industry, both the utilities and the fuel fabricators, tend to move forward as both parties acquire a reasonable confidence in the next step. In a sense, that has really been the history. The first Yankee Row plant was designed for burnups between 6,000 and 7,000. In the early seventies, the mid-20,000 was the accepted range. We have gradually gained confidence. We tend to move forward, I think, relatively in unison if we can, simply because of competitive factors, and I think that is an important reason to maintain more than one vendor. It really is an important competitive issue if you are the only vendor with the experience that lets you justify a more aggressive offering.

Mr. **Hall**. Mr. Lowery.

Mr. **Lowery**. No questions.

Mr. **Hall**. Mr. Ottinger, the gentleman from New York?

Mr. **Ottinger**. Thank you, Mr. Chairman. I appreciate your being here today and Mrs. Bouquard for arranging these hearings.

I have recently read that the French are proceeding with a high-burnup program, setting more or less the same goals this program does, 50,000 to 60,000 MWD/MTU's. If we abandon our program, what would that mean in terms of lost business for the United States?

Dr. **Jacobi**. Westinghouse has had a close association with the French program. You are quite correct that they are actively pursuing a high burnup program with very similar goals. We have technical exchange agreements with them and are fairly closely aware of what they are doing. My perception would be that today their program has the same objective but it is about 2 years behind our program. They also have a fuel assembly design which is very similar to ours. It has acquired its own unique Gallic characteristics. While some data can move back and forth between programs and be quite useful, the programs are not quite completely interchangeable.

In terms of the impact on the international sales of fuel, the barriers I think are probably more political than technical. The French, for example, have a national objective of independence in fuel supply. Most other developed nations have their own institutions and a determination to keep things as sensitive as mass energy production within their own borders. So I would tend to believe the implications for international fuel trade are probably not too great at this time.

Mr. OTTINGER. Is there a chance that if we did not pursue this, the French would be selling this equipment here?

Dr. JACOBI. There is a chance, but I firmly believe that our technology is ahead of the French now, and it is my intention to keep it that way.

Mr. OTTINGER. Dr. Pryor, you indicated that the program probably would not be pursued, at least not at the same rate, if the U.S. Government dropped its participation.

Dr. PRYOR. Yes, sir.

Mr. OTTINGER. We have seen so many developments that were made in the United States, where we are technologically ahead, disappear to foreign manufacturers for one reason or another. Is that a real concern?

Dr. PRYOR. I do not know that this is a real concern at this point. I would agree with what my colleague has said here, that I think the obstacles to French competition in this country for nuclear fuel, as well as any other foreign country, are more political. There are other factors involved that would outweigh any technical differences that might result from this program not going forward.

Mr. OTTINGER. The present program is aimed at extending burnup to 50,000 MWD/MTU, which would raise the possibility of reducing spent fuel generation by 40 percent. Now, we are told burnups of 80,000 MWD/MTU are possible and would cut spent fuel by over 60 percent. What is your assessment of the feasibility, the economics, and the timeframe within which that might be achieved, and whether the Department of Energy ought to be involved in pushing up the technology to reach these higher goals?

Dr. PRYOR. That is a good question. I would say, at this point, I think we ought to walk before we run. I think we have some technical challenges to face to reach the 50,000 goal right now. We are into the program, we are getting data now, and we need to complete the program. Let us get closer toward realization of the 50,000 goal before we decide how realistic an 80,000 goal may be.

Dr. JACOBI. I think I would echo that sentiment. That does not mean that 50,000 is an ultimate limit. I do not think so, but I think we ought to gain experience on an evolutionary basis. The DOE program can help us make that evolution occur more rapidly. The breeder program has shown that you can irradiate fuel to 100,000 MWD/MTU and satisfactorily contain it within the rod. But one concern is that water is a substantially more corrosive medium than sodium is, and we really do not have good experience with zirconium components in water for periods of 10 or 12 years, at high temperatures, and with fluctuating chemistry. So it might take some time to get substantially beyond the 50,000.

Mr. OTTINGER. Are you working on that technology? Is research being done on higher burnup technology?

Dr. JACOBI. I am not aware of programs that are aimed significantly beyond 50,000 MDW/MTU for light water reactors.

Dr. PRYOR. Nor am I.

Mr. OTTINGER. In hearings that my subcommittee held in October 1981, it was indicated to us that extended burnup is only one of several fuel efficiency improvements that could lead to savings of 25 percent for reactors and 33 to 43 percent fuel savings for advanced light water reactor designs. Are you pursuing these other efficiency improvements?

Mr. ANDREWS. Yes, sir. We are looking at the axial blanket designs, and we have demonstration assemblies in for that design. We are also looking at very low leakage fuel management and annular pellets that have the capability of adding some benefits. We are also looking at a number of others that have been identified in the past.

Mr. OTTINGER. How far are those away from commercial application? Has DOE assistance been requested or required?

Mr. ANDREWS. We have 40 assemblies of axial blanket design going into Rancho Secco this summer, and they will be followed by full batches of that design in the future cycles. We will be offering that as a commercial product. DOE has gotten the idea going. We will be commercializing that idea. As far as low leakage fuel management, we have been offering that for years, and it is a natural extension that goes with extended burnup. We feel that we brought low leakage fuel management to the program and are leading in using that in extended burnup applications.

[The material follows:]

News Release
GPU Nuclear

Public Information Services

Three Mile Island
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For Further Information
Contact: John Fidler or Doug Bedell

For Release: Immediately

Date: February 1, 1983
#10-83N

UPDATED CLEANUP COST, SCHEDULE ESTIMATE FOR TMI-2

Middletown, PA -- An update of the 1981 schedule for the defueling and decontamination of Three Mile Island Unit 2 places the completion of the program in the middle of 1988 for about the same, $1 billion cost that was estimated in 1981.

Using assumptions based on the projected, though uncertain, funding levels for the next five years, GPU Nuclear Corporation said today that the revised cost estimate is about $975 million, including allowances for inflation. The last estimate, which was made in July 1981 and assumed no funding constraints after January 1982, projected the cleanup as being completed during 1986 at a cost of $1,034 billion.

The new cleanup assessment was prepared by GPU Nuclear with the assistance of its contractors in the cleanup, particularly its lead contractor, the Bechtel Corporation. It is based on evaluations of plant conditions and funding forecasts as of December, 1982.

The new assessment has been sent to the Nuclear Regulatory Commission.

Although the target completion date is forecast to have slipped by approximately two years, a key element of the program, the removal of the damaged fuel from the Unit 2 reactor, could still begin within the time frame projected by the 1981 estimate, or 1985, and be completed during 1986.

The end point of the cleanup assumed in the study is the return of the plant to a radiological condition typical of normal operating plants. There is no provision in the cost estimate for either decommissioning or reconstructing Unit 2. A decision on those alternatives will be made in the later stages of the cleanup itself.

Because of the unique nature of the cleanup, uncertainties continue to exist that could change the scope of the program. Further updates of schedule and costs will be made as the effort proceeds.

The new estimate considers five different cases, or scenarios, for cost and scheduling. For the purposes of the estimate, GPU Nuclear judged the scenario of the selected base case (Case 1 in the Report) as the most reasonable assumption in terms of funding requirements.

The range of completion dates for the other four cases, and their costs, is from December 1987 - the earliest - at an estimated $950 million, to December 1989 -- the latest -- at an estimated $1.041 billion.

A more complete listing and explanation of the five cases is attached to this statement. In all cases, the estimates are in mid-1983 dollars, with escalation allowances for the years 1984 and later at 8 percent per year compounded.

Robert C. Arnold, president of GPU Nuclear, expressed encouragement with the new information and with the prospect that the job can be done for less than the previous estimates.

"I am particularly encouraged," he said, "by the substantial progress made to date, especially the very successful decontamination of accident-related water and by our ability to develop useful technical data and observations of conditions within the reactor itself."

Bahman K. Kanga, the director of TMI-2, said "Future studies will be made as new information about plant conditions and funding for the cleanup becomes available.

Because exact sources of funding for the remainder of the cleanup are uncertain, and because of the unique nature of the work still to be done, this new assessment may well have to be further revised.

"Additional work will be required after completion of the cleanup," Kanga said, "regardless of the decision on the ultimate disposition of the plant (i.e., decommissioning or restoration). The program as presently structured will not achieve a decommissioning or ready-for-restart status."

The new, $975 million overall cost estimate results from cost decreases and increases in various categories of work that reflect experience in the cleanup to date. The updated program also reflects shifts in some activities between categories to define more consistently the nature of activities.

Decreases of $177 million from the 1981 estimate are noted in the areas of waste processing facilities, miscellaneous support facilities, decontamination and defueling facilities and non-safety related systems and maintenance. Cost increases of $118 million are shown in the areas of escalation due to schedule extension, reactor disassembly and defueling, decontamination and fuel shipment, storage and disposal costs.

Work remaining in the cleanup falls into eleven general categories, as follows (Amounts are in 1983 dollars):

-- Operation of existing and modified plant systems and equipment required to maintain the reactor core in a safe condition -- $36 million.

-- Site support services, other than those involved above, required to support site activities but not directly associated with any specific construction end-product or operating facility. These include security, quality assurance/quality control, procurement, warehousing, accounting, training, industrial health and safety until core removal -- $26 million.

-- Decontamination of auxiliary building and contaminated equipment and processing of auxiliary and fuel handling building contaminated water -- $78 million.

-- Processing of contaminated water in the containment building and reactor coolant system -- $9 million.

-- Additional facilities required to decontaminate the containment building. Includes design and construction of a volume reduction facility, containment recovery service building and a personnel access facility -- $63 million.

-- Gross decontamination of the containment building to permit fuel removal operations to proceed within acceptable radiological limitations -- $76 million.

-- Reactor head and core removal. Includes engineering, consultant and direct labor associated with technical preparation, removal of reactor head and internals, dismantling, inspection and transfer of core to the fuel pool -- $119 million.

-- Additional facilities required to house temporarily contaminated equipment and material removed from the containment building -- $3 million.

-- Additional decontamination of the containment building and removal of contaminated equipment and materials to staging areas -- $92 million.

-- Operation of existing plant systems after the damaged core is removed from the reactor until completion of decontamination -- $10 million.

-- Site support services, other than the operating staff noted above, required to support site activities during the interval between removal of the damaged core until completion of decontamination -- $12 million.

The above categories total $524 million in work remaining to be done, in 1983 dollars. A total of $339 million has already been spent on the cleanup. The addition of $112 million for escalation due to inflation from 1984 to mid-1988 brings the total projected cost of the cleanup under this assessment to $975 million.

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February 1, 1983

FACT SHEET

TMI UNIT II SCHEDULE UPDATE

Summary of Cases Analyzed

In the preparation of this program estimate, several alternative cases were considered. In all of the cases, the base amounts are stated in 1983 dollars, in order that comparisons can be made without the complications of escalation. The cases that were considered are summarized below. Case 1 is the basis of the exhibits in the body of the report and represents the program baseline. Appendix A of the report addresses the other alternatives that were considered. A brief description of the various cases is as follows:

Case 1: Maximum allowable cash flow of $76 million for 1983, $92 million for 1984, and $100 million for 1985 and higher. Actual (i.e., current dollars) cash flow will be higher in 1984 and later due to escalation.

This is the base case for the program estimate and is considered to be a conservative, but reasonable, estimate of the availability of funds for the program. It places the funding priority on fuel removal until that milestone is achieved, consistent with other safety concerns.

Case 2: Maximum allowable cash flow of $76 million for 1983, and $100 million for 1984 and later in current dollars.

This is a more conservative scenario in which the funding level is not able to be adjusted for inflation.

Case 3: Same as Case 1 with the exception of 1985, which has unlimited cash flow applied to fuel removal activities as required to complete those activities in 1985.

This case examines the funding increment needed in 1985 to accomplish fuel removal in about one year instead of the 18 months projected for Case 1.

Case 4: Same as Case 1 with the exception of 1983 and 1984, which are increased by $10 million each year (1983 dollars).

This case examines the effect on the schedule for fuel removal of a modest near-term increase in funding compared with the Case 1 assumption.

Case 5: Same as Case 4 with the exception of 1984 and 1985, which have unlimited cash flow as required both to expedite the start of fuel removal and reduce the fuel removal time to 12 months.

This case further develops the effect of additional funding (until fuel is removed) on the forecast of when fuel removal would be achieved. It is thought to be essentially an unlimited funding case as well, although it was not developed using that assumption. The judgment of project management is that technical, operational, and perhaps regulatory factors would also limit progress at this level of effort.

Program Estimate Comparison

	Total ($ Millions) Escalated	To Go ($ Millions) 1983 Dollars	Program Completion
July '81	1034.0	644.8	August 1986
Case 1	974.7	523.8	June 1988
Case 2	1041.3	553.6	December 1989
Case 3	971.2	525.5	June 1988
Case 4	961.7	520.8	March 1988
Case 5	949.6	520.1	December 1987

Note: Projected expenditures through December 31, 1982 are $339 million.

Program Estimate Basis

The program estimate effort has been based, in large part, on the various technical assumptions and approaches that have evolved in each of the major recovery program areas. Some of these are well established and documented, while some are in the developmental stage. For clarity, a number of these key technical bases are summarized here:

A. Dose Reduction

In recent months it has become clear that gamma dose rates in containment are remaining at elevated levels despite substantial progress in gross decontamination and removal of contaminated water from the basement. These dose rates are higher than anticipated and, if unchanged, would result in unacceptably high cumulative personnel exposures during the next phases of decontamination and defueling. Therefore, an aggressive program of in-containment dose reduction has been developed and is being implemented. The program has three major parts as follows:

Part A

Perform immediate actions to reduce personnel exposure during access and during activities in the near term (to be accomplished by the first quarter of 1983).

Part B

Take appropriate actions to remove or shield radiation sources in the reactor building basement thereby permitting less restrictive personnel access. Control the sources to improve RB atmospheric environment and remove the respiratory protection equipment during the next 18 to 24 months.

Part C

Complete radiation source control to reach objectives of the completion criteria.

B. Decontamination/Stabilization

The term "decontamination" has been broadly applied to the removal of both loose and fixed radioactive material from building and system (external and internal) surfaces.

Beyond decontamination per se, the Technical Planning Department is now addressing the issue of Building and System "stabilization". Stabilization is defined as that work necessary to establish building and system conditions that represent no (or acceptably low) radiological hazard to the public and to workers from direct radiation, in-plant or external releases of radioactive materials, plausible accidents and the like. Stabilization actions are being planned on a case-by-case basis, and may include full or partial decontamination, prevention of access to unused contaminated spaces, draining and isolation of contaminated fluid systems or subsystems, or other techniques tailored for specific problem areas.

With respect to systems decontamination, the stabilization studies in progress may influence the final decision as to the degree of internal cleanliness required, and therefore, the techniques to be employed. Primarily at issue is the question of chemical decontamination. The types of chemicals to be used (and the need for chemical decontamination) will be dictated, in part, by stabilization requirements, and in turn, will dictate waste handling, processing (including volume reduction) and disposal requirements. For the purpose of this estimate, it is assumed that widespread chemical decontamination will be required, and attendant waste handling capabilities are required.

C. Reactor Disassembly and Defueling

1. Head Removal - For the estimate, it is assumed that head removal is conducted in accordance with the Head Removal Planning Study, issued on October 15, 1982. The basic approach involves installation of a high-integrity vessel flange-to-defueling canal seal, dry lifting of the head, bagging for contamination control, and transfer to the (modified) head storage stand for subsequent decontamination. Following head lift, the internals indexing fixture will be installed, sealed and partially filled with water to provide shielding (three feet of water) from the plenum upper surface. The plan includes contingency provisions for canal flooding during head lift if necessary.

2. Plenum Removal - The plenum removal plan is under development. Based on preliminary work, it was assumed for the estimate that intact plenum removal will be possible (i.e., in-vessel disassembly of the plenum will not be necessary). Prerequisites for plenum removal are very similar to those for fuel removal, due to the potential for fuel adherence to the plenum. The base plan presumes that the initial lift of the plenum can be done prior to canal flooding, and that the balance of the lift and subsequent removal from the vessel will be done wet (after flooding). The plenum will be stored underwater in the shallow end of the canal until dismantling, removal and disposal.

   Fuel Transfer and Storage - The estimate is based on the premise that fuel (to be found in various physical configurations) will be removed from the reactor vessel, placed in sealed steel containers, moved to one of two fuel transfer tubes, transferred to Fuel Pool "A", upended, and moved to new fuel racks in Pool "A" for interim storage prior to shipment from Three Mile Island. The estimate includes work associated with the supply and/or refurbishment of the above mentioned components and associated systems.

One specific activity that involves substantial effort, and as yet is not planned in detail, is the dismantling of the tank farm presently located in Fuel Pool "A". This tankage, along with associated piping and shielding is large, complex and contaminated. Removal of this equipment will be a major task. An allowance was made for this effort in the estimate.

3. Fuel Removal - Development of tools, equipment and systems for fuel removal is in its early stages. Conceptually, the devices to be employed will be adaptations of existing equipment with which there is extensive experience in the nuclear industry, although not necessarily in nuclear plant defueling. It is assumed at this point that very complex, totally remote-operated equipment will not be required for this job.

   Although detailed engineering work in this area is not available as a basis for precise estimating for the program estimate, the Quick Look examinations conducted in 1982 generally confirmed earlier planning assumptions regarding the condition of the core and suggest no reason to alter greatly the previous estimate. For schedule purposes "Completion of Fuel and Debris Removal" is defined as removal of fuel and debris from the original core region.

4. Fuel Shipping - The program estimate includes estimated costs for shipping all TMI-2 fuel to an unspecified DOE facility. It is assumed that standard NRC-licensed truck-mounted spent fuel shipping casks will be available for use.

D. Waste Processing and Disposal

1. Volume Reduction - The program estimate includes costs for the provision of volume reduction capability for processing chemical wastes used in system decontamination work. The estimate basis is an on-site evaporation system. However, other approaches such as one or more small capacity evaporators, contractor solidification services, or other methods may be preferrable. A study to make that determination is in progress and will be completed in September of 1983.

2. Refueling Canal Cleanup - The estimate includes costs for an on-line canal cleanup system to remove dissolved and suspended impurities for purposes of radiological protection and water clarity. The system may include modifications of one or more existing systems, including the Submerged Demineralizer System (SDS), EPICOR II, and the installed refueling canal cleanup system.

3. On-Site Radwaste Staging - The estimate includes expanded provisions for temporary on-site storage of radioactive waste materials. There is no provision for permanent on-site storage of waste materials. It is assumed that all waste material

generated in the Decontamination and Defueling Program, including processed solids and liquids, as well as contaminated material and equipment removed from the plant, will be shipped from the site for permanent disposal.

4. Processed Water - It is assumed for estimate purposes that processed water will be temporarily stored on-site and recycled for inplant decontamination use to the greatest extent possible. The estimate includes allowances for these activities, including the provision of expanded on-site storage (tank) capacity. A disposal method has not been selected.

5. Solid Waste Shipping and Disposal - As noted above, it is assumed for the estimate that all solid radioactive waste will be transported from Three Mile Island for disposal. This places a high degree of dependence on the availability of suitable disposal sites for all TMI-2 wastes. This presumption is considered reasonable in light of both the NRC-DOE Memorandum of Understanding and the substantial progress made during the last year in the area of waste shipping and disposal.

   It is assumed that all waste shipping will be via truck. No rail shipping is anticipated.

E. Other Support Facilities

The estimate includes the provision of a Containment Recovery Service Building (CRSB) to support major in-containment decontamination work. This building is a large structure that will enclose the Reactor Building Equipment Hatch and provide capability for efficient ingress and egress by a large work force, contamination control, equipment decontamination, packaging and shielded staging.

F. Program End Point

The Decontamination and Defueling Program will achieve a defueled and stable plant that will provide a suitable starting point for subsequent actions directed toward plant restart or decommissioning. At the end of the program, the residual contamination and radiation levels will be similar to those typically found in an operating plant. Several points are important here:

- No decision has yet been made on the ultimate disposition (restart or decommissioning) of TMI-2, nor is a decision anticipated until after fuel removal.

- The specific activity end-points are subject to change. For example, stabilization consideration may permit relaxation of decontamination objectives in some areas.

- Additional work will be required after completion of the Program, regardless of the ultimate plant use decision. The precise character, extent and timing of this work is not known at this point. It should be understood that the Decontamination and Defueling Program as presently structured will not achieve a decommissioned or ready-for-restart status.

TMI-2
RECOVERY PROGRAM ESTIMATE

(Revision 2, December 30, 1982)

I EXECUTIVE SUMMARY

Historical Development of Recovery Program Estimates

Shortly after the accident at Three Mile Island Unit 2, efforts were undertaken to develop a preliminary estimate of the costs of the cleanup program. There was a clear understanding that the estimate would likely require substantial changes because of the unique nature of the accident, the many unknowns associated with the condition of the plant, and the difficulties in defining the level of technical and construction effort in the face of so many uncertainties.

In the year following the accident, many man-hours were devoted to the cleanup effort, the acquisition of technical data, and the development of detailed plans for the complex recovery activities. These efforts provided additional insights into the effort that would be necessary to defuel and decontaminate the plant.

In August 1980, a Recovery Program Estimate was issued that constituted the first definitive estimate of the TMI-2 cleanup and recovery program. It incorporated an assessment of plant conditions as of June 1980, a work plan and schedule that benefited from the recovery program experiences of the preceding 15 months, and a significantly improved understanding of the magnitude of cost and complexity of the Recovery Program. However, a number of technical and programmatic uncertainties still remained, and the regulatory environment at that time had a substantial impact on the planning activities at Three Mile Island. The containment building had been entered only once as of the August report, and the full scope of the problems in defueling and decontaminating the reactor remained unknown. Additionally, the uncertainties of waste disposal, as impacted by the ongoing Federal and State regulatory developments in that field, gave rise to a certain speculative quality to the estimate in that area.

In November 1980, an evaluation of regulatory conditions and a better definition of financial resources were used for revising the cost assessment used in the preparation of the Programmatic Environmental Impact Statement (PEIS). The PEIS estimate included only the defueling and decontamination portion of the recovery program costs. Activities equivalent to normal operations and maintenance were excluded, but an inflation factor was included. That estimate also considered the effects of a stretched-out schedule caused by the reduction in the level of effort, which occurred in September 1980 in response to financial constraints and regulatory uncertainties pending issuance of the final PEIS.

The next major effort to update the program cost and schedule was completed in mid-1981 and was titled "TMI-2 Recovery Program Estimate (Revision 1, July 1981)." That assessment was based upon updated evaluations of the sequence and duration of program activities. That program estimate assumed unlimited funding beginning January 1982, but did not include cost estimates for either decommissioning or reconstruction of the plant.

The current cost estimate contained in this document was completed in December 1982. It reflects further development of the planning of the sequence and duration of cleanup activities, technical information evaluated as of that date, and the accumulated experience from cleanup activities since the accident. The sequence logic for the cleanup is documented under separate cover in the "Decontamination and Defueling Program Plan."

Summary of Recovery Program Estimate

This estimate indicates that, despite delays in the acceleration of cleanup efforts compared with the assumptions used for the July 1981 TMI-2 Recovery Program Estimate, the Program can be completed for about the same total of dollars. Compared with the July 1981 plan, which estimated completion in August 1986 at a cost of $1,034 million, the various cases analyzed for this report indicate costs of $950 million to $1,041 million with associated completion dates varying from the end of 1987 to the end of 1989. The base case (Case I) has a scheduled completion date of mid-1988 at a total cost of $975 million. Appendix B of the report summarizes the major contributions to differences in the current cost estimate from the estimate of July 1981. (See Table 7, page A-2, and Table 8, page A-4 for summary presentations of cost estimates and major milestone dates.)

Major Assumptions and Limitations

Although substantial technical uncertainties, which may affect the cleanup program, still exist, this estimate is believed to be a reasonable forecast of program requirements and associated costs and schedules. Nevertheless, it must be recognized that the program is subject to major variations that may affect significantly costs or schedule or both. New program estimates will be developed as new information or circumstances develop that indicate the need for revisions to the program plan. Due to the research and development nature of this program and the uncertainties involved, it is not appropriate to assign cost or schedule contingency at this time. Contingency can only be reasonably assessed when the limits of uncertainties can be identified.

The program end point assumed for this report will not establish plant conditions permitting either decommissioning or reconstruction. The objective of the program is to return the plant to a radiological condition (i.e., radiation and contamination levels) typical of normal operating plants. There will be substantial additional effort and associated costs necessary for either decommissioning or reconstruction of the unit. Pending completion of either of those alternatives, the plant systems would have to be operated, monitored, and maintained sufficiently to prevent uncontrolled releases of low levels of radioactive material from the plant.

The program plan has been developed with "fuel removal" as the priority interim objective. That terminology has been adopted for purposes of program planning to signify when the fuel material has been removed from the volume of the reactor vessel occupied by the original core. It should not be interpreted to indicate that all fuel material has been recaptured. There will be an additional year or more associated with recovery of fuel fines, and perhaps some fragments, which were distributed throughout the reactor coolant and associated systems on the day of the accident.

While the base case and alternatives described in this report assume that activities are funding-limited, it is anticipated that for the higher funding scenario described in Case 5, and perhaps even for much of Cases 3 and 4, most of the critical path activities would be at or near a rate of progress that would be controlled by technical and operational considerations.

Summary of Cases Analyzed

In the preparation of this program estimate, several alternative cases were considered. In all of the cases, the base amounts are stated in 1983 dollars, in order that comparisons can be made without the complications of escalation. The cases that were considered are summarized below. Case I is the basis of the exhibits in the body of the report and represents the program baseline. Appendix A of the report addresses the other alternatives that were considered. A brief Description of the various cases is as follows:

Case I: Maximum allowable cash flow of $76.0MM for 1983, $92.6MM for 1984, and $100.0MM for 1985 and later. Actual (i.e., current dollars) cash flow will be higher in 1984 and later due to escalation.

This is the base case for the program estimate and is considered to be a conservative, but reasonable, estimate of the availability of funds for the program. It places the funding priority on fuel removal until that milestone is achieved, consistent with other safety concerns.

Case II: Maximum allowable cash flow of $76.0MM for 1983, and $100.0MM for 1984 and later in current dollars.

This is a more conservative scenario in which the funding level is not able to be adjusted for inflation.

Case III: Same as Case I with the exception of 1985, which has unlimited cash flow applied to fuel removal activities as required to complete those activities in 1985.

This case examines the funding increment needed in 1985 to accomplish fuel removal in about one year instead of the 18 months projected for Case I.

Case IV: Same as Case I with the exception of 1983 and 1984, which are increased by $10.0MM each year (1983 dollars).

This case examines the effect on the schedule for fuel removal of a modest near-term increase in funding compared with the Case I assumption.

Case V: Same as Case IV with the exception of 1984 and 1985, which have unlimited cash flow as required both to expedite the start of fuel removal and reduce the fuel removal time to 12 months.

This case further develops the effect of additional funding (until fuel is removed) on the forecast of when fuel removal would be achieved. It is thought to be essentially an unlimited funding case as well, although it was not developed using that assumption. The judgment of project management is that technical, operational, and perhaps regulatory factors would also limit progress at this level of effort.

Comparative analysis of these alternatives is presented in Appendix A of this report.

Management Control Systems

This estimate was developed around the framework of a Work Breakdown Structure (WBS). The WBS is a hierarchical breakdown of all program activities required to accomplish the program objectives. The major program activities are outlined and subdivided into progressively smaller tasks until each task becomes a discrete manageable unit for program planning and control. These tasks are then used to develop program baseline schedules and costs that can be summarized to progressively higher levels for overall program management. All the various tasks can be summarized into six major categories of work. These six categories are as follows:

1. Program Support
2. Dose Reduction, Stabilization and Decontamination
3. Reactor Disassembly and Defueling
4. Radioactive Waste Management
5. General Recovery Facilities/Systems
6. Plant Stability and Safety

Within the body of this report, all the tabulations and figures are displayed based upon estimates developed by WBS. Further descriptions of general work scope included within each of the six major categories is provided on pages 20 and 21.

Summary of Work Activities by Categories

The following table presents the estimate in the categories A through K similar to those used in the July 1981 Recovery Program Estimate.

TMI-2 RECOVERY PROGRAM ESTIMATE
EXECUTIVE COST SUMMARY
TABLE 1

DESCRIPTION OF ACTIVITY	(1983-1988) Estimated Cost[2] In Millions	Schedule[1] Duration
MAINTAINING PLANT IN SAFE CONDITION		
A. Operation of existing and modified plant systems and equipment required to maintain the core in a safe condition. Includes operating personnel, support staff and consumable supplies until the core is removed from the reactor vessel.	36.	Present - Jun '86
B. Site support services, other than the operating staff noted above required to support site activities but not directly associated with any specific construction end-product or operating facility. These support services include security, QA/QC, procurement, warehousing, accounting, training, industrial health and safety, etc. until the core is removed from reactor vessel.	26.	Present - Jun '86
C. Decontamination of auxiliary buildings and contaminated equipment and processing of auxiliary and fuel building contaminated water. Includes operating personnel, radiological control staff and contractor personnel required to operate the associated waste processing systems and laundry facilities; construction of interim waste staging facilities and associated waste disposal.	78.	Present - Jun '88
D. Processing of highly contaminated water in the containment building and reactor coolant system plus water contaminated during cleanup activities. Includes installation and operation of associated water processing systems and additional waste staging capability.	9.	Present - Dec '87
Subtotal (A-D)	$149.	

NOTES:

1. The schedule duration represents the time span of substantial activity. Some minor activity or engineering and planning may occur before and after the dates shown. Categories indicating "present" time are continuation of activities from prior years.

2. Costs are in constant 1983 dollars.

TMI-2 RECOVERY PROGRAM ESTIMATE
EXECUTIVE COST SUMMARY
TABLE 1 (Continued)

DESCRIPTION OF ACTIVITY ADDITIONAL COST TO DEFUEL REACTOR FOR CONTAINMENT DECONTAMINATION	(1983-1988) Estimated Cost[2] In Millions	Schedule[1] Duration
E. Additional facilities required to decontaminate the containment building. Includes design and construction of volume reduction facility, containment recovery service building, personnel access facility, laundry, etc.	63.	Present - Jun '86
F. Phase I and II decontamination of the containment building to permit fuel removal operations and to satisfy established completion criteria. Includes installation of decontamination support systems, shielding and manual, supervisory and support personnel for decontamination operations.	76.	Present - Mar '88
G. Head and core removal. Includes engineering, consultant and direct labor associated with technical preparation, removal of reactor head and internals, dismantling, inspection and transfer of core to fuel pool	119.	Present - Jun '86
H. Additional facilities required to temporarily house contaminated equipment and material removed from the containment building. Includes the engineering design and construction of additional radwaste staging facilities, solid and liquid.	3.	Jan '86 - Jun '86
I. Additional decontamination of the containment building and removal of contaminated equipment and materials to staging areas. Includes the operation of associated decontamination, waste packaging, processing and disposal operations.	92.	Present - Jun '88

NOTES:

1. The schedule duration represents the time span of substantial activity. Some minor activity or engineering and planning may occur before and after the dates shown. Categories indicating "present" time are continuation of activities from prior years.

2. Costs are in constant 1983 dollars.

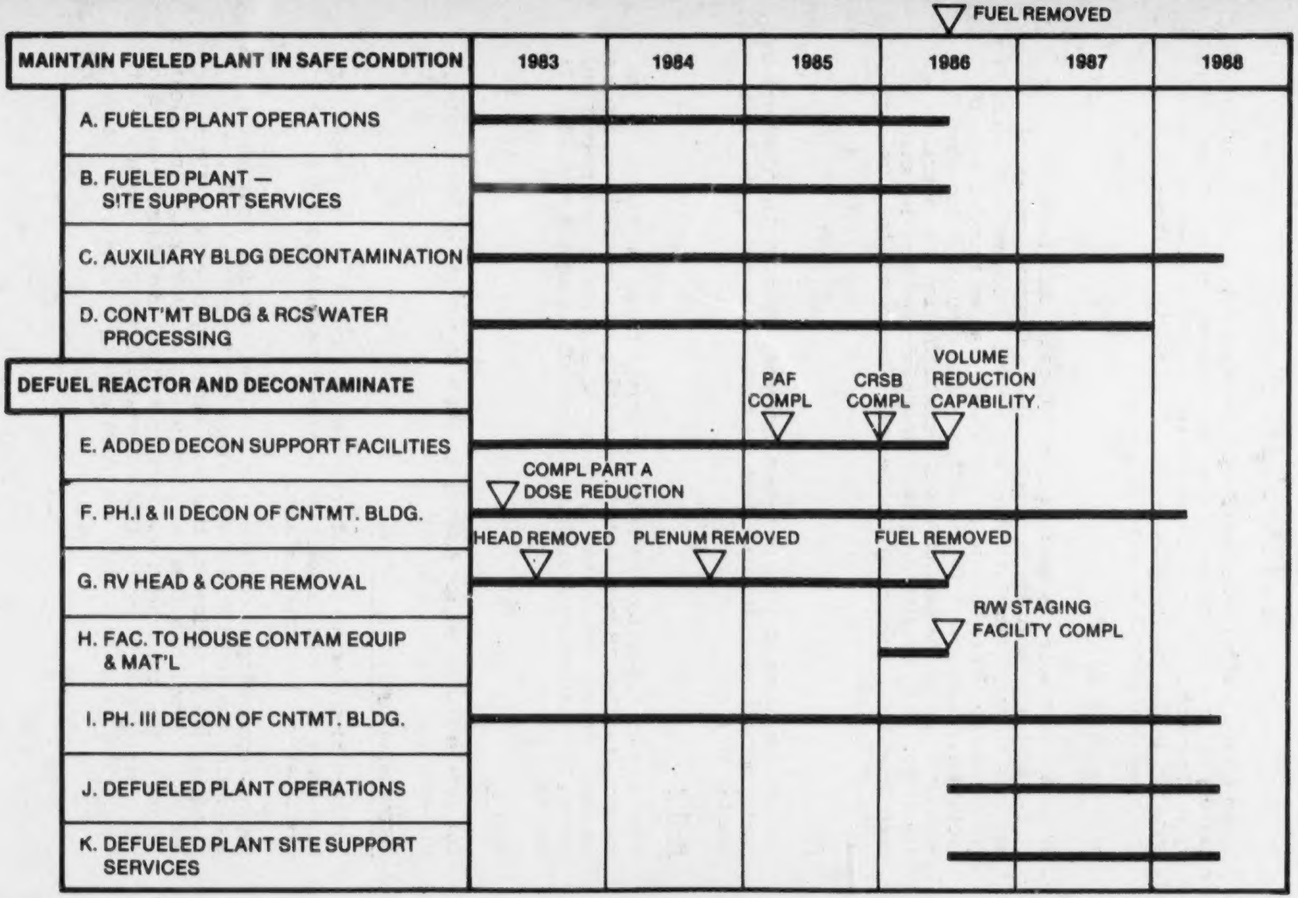
TMI-2 RECOVERY PROGRAM ESTIMATE
EXECUTIVE COST SUMMARY
TABLE I (Continued)

DESCRIPTION OF ACTIVITY	(1983-1988) Estimated Cost[2] In Millions	Schedule Duration[1]
J. Operation of existing plant systems after the damaged core is removed from the reactor until completion of decontamination. Includes operating personnel, support staff and consumable supplies.	10.	Jul '86 - Jun '88
K. Site support services, other than the operating staff noted above, required to support site activities but not directly associated with any specific construction end-product or operating facility during interval between removal of damaged core until completion of decontamination.	12.	Jul '86 - Jun '88
Subtotal (E-K)	$375.	
Total (A-K)	$524.	
Escalation	112.	
Expended as of 12/82	339.	
Program Total	$975.	

NOTES:

1. The schedule duration represents the time span of substantial activity. Some minor activity or engineering and planning may occur before and after the dates shown. Categories indicating "present" time are continuation of activities from prior years.

2. Costs are in constant 1983 dollars.



TMI-2 RECOVERY PROGRAM ESTIMATE
ACTIVITY CHART
FIGURE 1

II PROGRAM ESTIMATE BASIS

The program estimate effort has been based, in large part, on the various technical assumptions and approaches that have evolved in each of the major recovery program areas. Some of these are well established and documented, while some are in the developmental stage. For clarity, a number of these key technical bases are summarized here:

A. DOSE REDUCTION

In recent months it has become clear that gamma dose rates in containment are remaining at elevated levels despite substantial progress in gross decontamination and removal of contaminated water from the basement. These dose rates are higher than anticipated and, if unchanged, would result in unacceptably high cumulative personnel exposures during the next phases of decontamination and defueling. Therefore, an aggressive program of in-containment dose reduction has been developed and is being implemented. The program has three major parts as follows:

PART A

Perform immediate actions to reduce personnel exposure during access and during activities in the near term (to be accomplished by the first quarter of 1983).

PART B

Take appropriate actions to remove or shield radiation sources in the reactor building basement thereby permitting less restrictive personnel access. Control the sources to improve RB atmospheric environment and remove the respiratory protection requirement during the next 18 to 24 months.

PART C

Complete radiation source control to reach objectives of the completion criteria.

B. DECONTAMINATION/STABILIZATION

The term "decontamination" has been broadly applied to the removal of both loose and fixed radioactive material from building and system (external and internal) surfaces.

Beyond decontamination per se, the Technical Planning Department is now addressing the issue of Building and System "stabilization". Stabilization is defined as that work necessary to establish building and system conditions that represent no (or acceptably low) radiological hazard to the public and to workers from direct radiation, in-plant or external releases of radioactive materials, plausible accidents and the like. Stabilization actions are being planned on a case-by-case basis, and may include full or partial decontamination, prevention of access to unused contaminated spaces, draining and isolation of contaminated fluid systems or subsystems, or other techniques tailored for specific problem areas.

With respect to systems decontamination, the stabilization studies in progress may influence the final decision as to the degree of internal cleanliness required, and therefore, the techniques to be employed. Primarily at issue is the question of chemical decontamination. The types of chemicals to be used (and the need for chemical decontamination) will be dictated, in part, by stabilization requirements, and in turn, will dictate waste handling, processing (including volume reduction) and disposal requirements. For the purpose of this estimate, it is assumed that widespread chemical decontamination will be required, and attendant waste handling capabilities are required.

C. REACTOR DISASSEMBLY AND DEFUELING

1. Head Removal - For the estimate, it is assumed that head removal is conducted in accordance with the Head Removal Planning Study, issued on October 15, 1982. The basic approach involves installation of a high-integrity vessel flange-to-defueling canal seal, dry lifting of the head, bagging for contamination control, and transfer to the (modified) head storage stand for subsequent decontamination. Following head lift, the internals indexing fixture will be installed, sealed and partially filled with water to provide shielding (three feet of water) from the plenum upper surface. The plan includes contingency provisions for canal flooding during head lift if necessary.

2. Plenum Removal - The plenum removal plan is under development. Based on preliminary work, it was assumed for the estimate that intact plenum removal will be possible (i.e., in-vessel disassembly of the plenum will not be necessary). Prerequisites for plenum removal are very similar to those for fuel removal, due to the potential for fuel adherence to the plenum. The base plan presumes that the initial lift of the plenum can be done prior to canal flooding, and that the balance of the lift and subsequent removal from the vessel will be done wet (after flooding). The plenum will be stored underwater in the shallow end of the canal until dismantling, removal and disposal.

   Fuel Transfer and Storage - The estimate is based on the premise that fuel (to be found in various physical configurations) will be removed from the reactor vessel, placed in sealed steel canisters, moved to one of two fuel transfer tubes, transferred to Fuel Pool "A", upended, and moved to new fuel racks in pool "A" for interim storage prior to shipment from Three Mile Island. The estimate includes work associated with the supply and/or refurbishment of the above mentioned components and associated systems.

One specific activity that involves substantial effort, and as yet is not planned in detail, is the dismantling of the tank farm presently located in Fuel Pool "A". This tankage, along with associated piping and shielding is large, complex and contaminated. Removal of this equipment will be a major task. An allowance was made for this effort in the estimate.

3. Fuel Removal - Development of tools, equipment and systems for fuel removal is in its early stages. Conceptually, the devices to be employed will be adaptations of existing equipment with which there is extensive experience in the nuclear industry, although not necessarily in nuclear plant defueling. It is assumed at this point that very complex, totally remote-operated equipment will not be required for this job.

   Although detailed engineering work in this area is not available as a basis for precise estimating for the program estimate, the Quick Look examinations conducted in 1982 generally confirmed earlier planning assumptions regarding the condition of the core and suggest no reason to alter greatly the previous estimate. For schedule purposes "Completion of Fuel and Debris Removal" is defined as removal of fuel and debris from the original core region.

4. Fuel Shipping - The program estimate includes estimated costs for shipping all TMI-2 fuel to an unspecified DOE facility. It is assumed that standard NRC-licensed truck-mounted spent fuel shipping casks will be available for use.

D. WASTE PROCESSING AND DISPOSAL

1. Volume Reduction - The program estimate includes costs for the provision of volume reduction capability for processing chemical wastes used in system decontamination work. The estimate basis is an on-site evaporation system. However, other approaches such as one or more small capacity evaporators, contractor solidification services, or other methods may be preferrable. A study to make that determination is in progress and will be completed in September of 1983.

2. Refueling Canal Cleanup - The estimate includes costs for an on-line canal cleanup system to remove dissolved and suspended impurities for purposes of radiological protection and water clarity. The system may include modifications of one or more existing systems, including the Submerged Demineralizer System (SDS), EPICOR II, and the installed refueling canal cleanup system.

3. On-Site Radwaste Staging - The estimate includes expanded provisions for temporary on-site storage of radioactive waste materials. There is no provision for permanent on-site storage of waste materials. It is assumed that all waste material generated in the Decontamination and Defueling Program, including processed

solids and liquids, as well as contaminated material and equipment removed from the plant, will be shipped from the site for permanent disposal.

4. Processed Water - It is assumed for estimate purposes that processed water will be temporarily stored on-site and recycled for inplant decontamination use to the greatest extent possible. The estimate includes allowances for these activities, including the provision of expanded on-site storage (tank) capacity. A disposal method has not be selected.

5. Solid Waste Shipping and Disposal - As noted above, it is assumed for the estimate that all solid radioactive waste will be transported from Three Mile Island for disposal. This places a high degree of dependence on the availability of suitable disposal sites for all TMI-2 wastes. This presumption is considered reasonable in light of both the NRC-DOE Memorandum of Understanding and the substantial progress made during the last year in the area of waste shipping and disposal.

   It is assumed that all waste shipping will be via truck. No rail shipping is anticipated.

E. OTHER SUPPORT FACILITIES

The estimate includes the provision of a Containment Recovery Service Building (CRSB) to support major in-containment decontamination work. This building is a large structure that will enclose the Reactor Building Equipment Hatch and provide capability for efficient ingress and egress by a large work force, contamination control, equipment decontamination, packaging and shielded staging.

F. PROGRAM END POINT

The Decontamination and Defueling Program will achieve a defueled and stable plant that will provide a suitable starting point for subsequent actions directed toward plant restart or decommissioning. At the end of the program, the residual contamination and radiation levels will be similar to those typically found in an operating plant. Several points are important here:

- No decision has yet been made on the ultimate disposition (restart or decommissioning) of TMI-2, nor is a decision anticipated until after fuel removal.

- The specific activity end-points are subject to change. For example, stabilization consideration may permit relaxation of decontamination objectives in some areas.

- Additional work will be required after completion of the Program, regardless of the ultimate plant use decision. The precise character, extent and timing of this work is not known at this point. It should be understood that the Decontamination and Defueling Program as presently structured will not achieve a decommissioned or ready-for-restart status.

III QUALIFICATIONS & ASSUMPTIONS

A. GENERAL

1. Estimate includes planned work scope remaining as of December 31, 1982.

2. Estimate is in mid-1983 dollars.

3. Escalation allowance for 1984 and later is 8% per year compounded.

4. Expenditure limitations for Case I are based on the following:

   Maximum allowable cash flow of $76.0MM for 1983, $92.6MM for 1984 and $100.0MM for 1985 and later. Actual cash flow will be higher in 1984 and later due to escalation.

5. Cost estimate is based on the current Decontamination and Defueling Plan.

6. Debt service on capital investment is excluded.

7. Estimate is based on in-containment work being accomplished during a 50-hour week consisting of five 10-hour days, Monday through Friday with selected second shift. Balance of activities will be performed based on a regular 40-hour work week.

8. Licensing actions and approvals must be complete prior to scheduled start of activities associated with decontamination and Reactor Disassembly and Defueling.

9. The estimates assume current regulatory guidance and site license requirements for radwaste disposal.

10. Fuel shipment and disposal will be made in 250 canisters (one canister per shipment). The current assumption is that GPU will bear the shipping, storage and disposal costs.

11. Equipment for decontamination, tooling for head, plenum and fuel removal and personnel ingress and egress will be available through both personnel air locks 1 and 2. Also the equipment hatch can be opened temporarily for the movement of large materials and components into or out of the containment.

12. No salvage value has been considered.

13. No cost or schedule contingency allowance has been included.

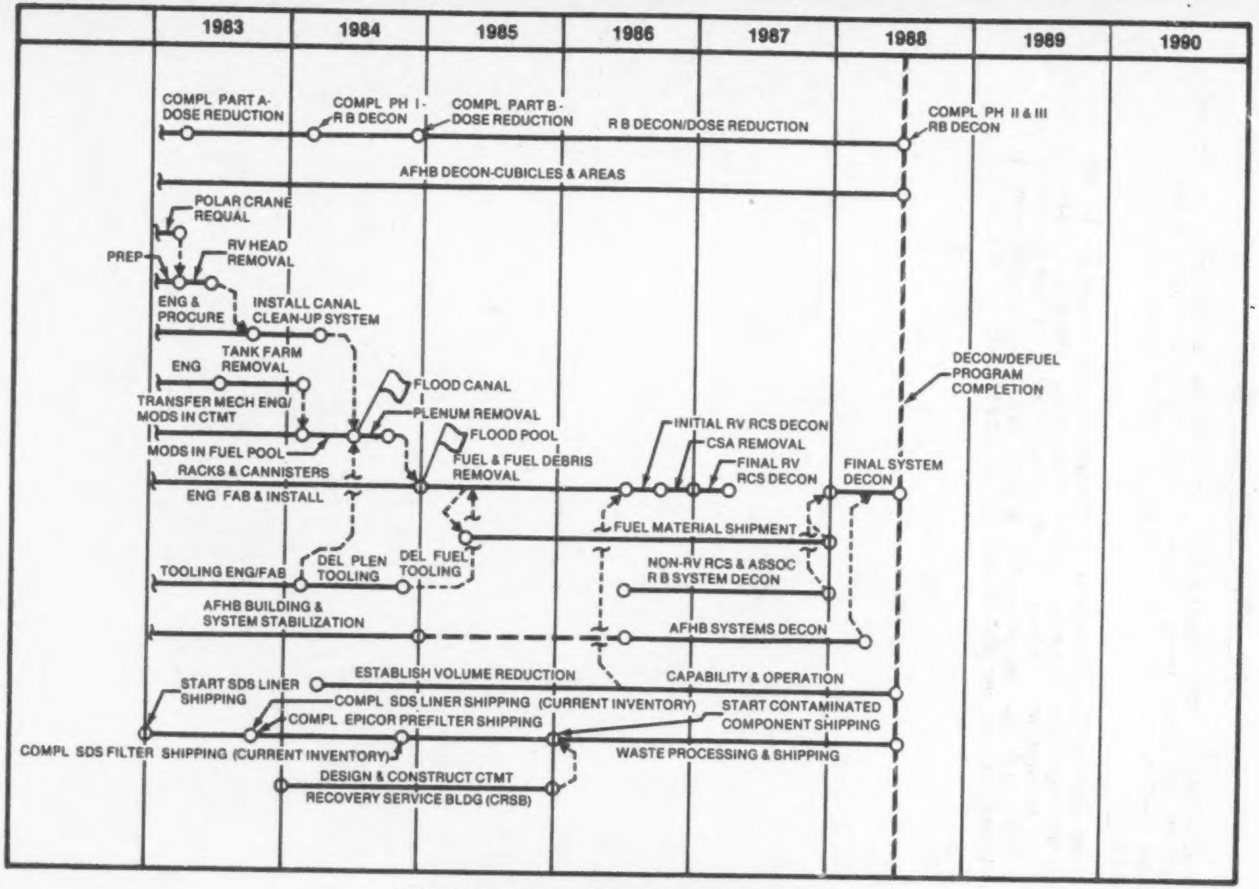
14. Maintenance of equipment and facilities as investment protection is specifically excluded.

15. Arrangements can be made for shipping all radwaste offsite.

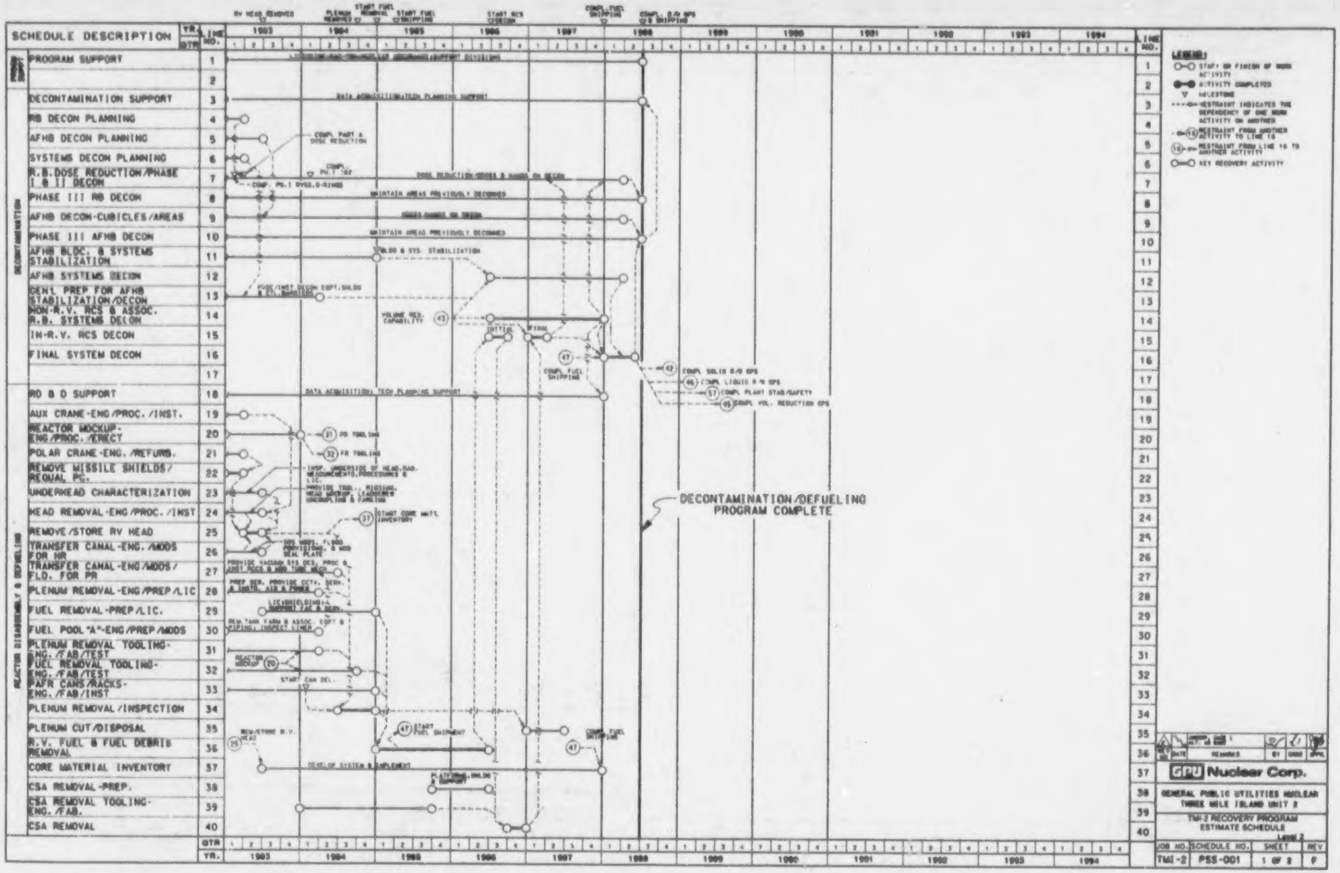
IV PROGRAM COSTS AND SCHEDULE

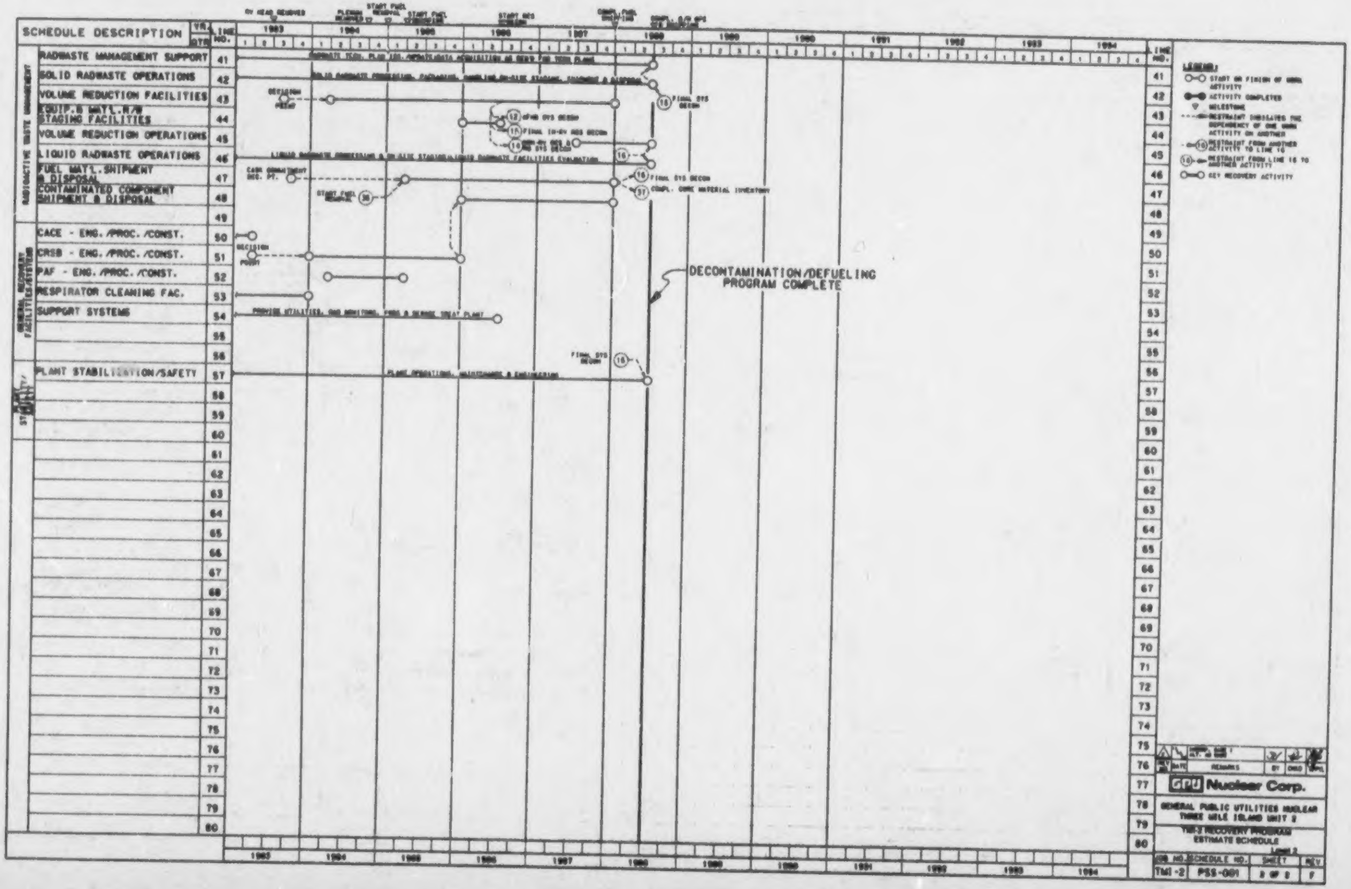
Program alternative Case I was used as the baseline for deriving the following schedule and cost breakdowns. Figure 2 summarizes the Program Summary Schedule (PSS-001, rev. F). Included on this schedule are the major program milestones.

The Program Summary Cash Flow showing the annual cost breakouts by WBS category and organization is presented in Table 4. These costs are all 1983 dollars, no escalation. Details of the annual cash flow are presented in Table 5. The distribution of cash from the funding categories among the various organizations and WBS categories is detailed in Table 6.



TMI-2 RECOVERY PROGRAM ESTIMATE
PROGRAM ACTIVITY SUMMARY
FIGURE 2


SCHEDULE DESCRIPTION
YR.
QTR.
LINE NO.
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
RV HEAD REMOVED
PLENUM REMOVED
START FUEL REMOVAL
START FUEL SHIPPING
START RCS DECON
COMPL. FUEL SHIPPING
COMPL. R/W OPS & SHIPPING
PROGRAM SUPPORT
DECONTAMINATION SUPPORT
RB DECON PLANNING
AFHB DECON PLANNING
SYSTEMS DECON PLANNING
R.B. DOSE REDUCTION/PHASE I & II DECON
PHASE III RB DECON
AFHB DECON-CUBICLES/AREAS
PHASE III AFHB DECON
AFHB BLDG. & SYSTEMS STABILIZATION
AFHB SYSTEMS DECON
GEN'L PREP FOR AFHB STABILIZATION/DECON
NON-R.V. RCS & ASSOC. R.B. SYSTEMS DECON
IN-R.V. RCS DECON
FINAL SYSTEM DECON
RD & D SUPPORT
AUX CRANE-ENG/PROC./INST.
REACTOR MOCKUP-ENG/PROC./ERECT
POLAR CRANE-ENG./REFURB.
REMOVE MISSILE SHIELDS/REQUAL PC.
UNDERHEAD CHARACTERIZATION
HEAD REMOVAL-ENG/PROC./INST
REMOVE/STORE RV HEAD
TRANSFER CANAL-ENG./MODS FOR HR
TRANSFER CANAL-ENG/MODS/FLD. FOR PR
PLENUM REMOVAL-ENG/PREP/LIC
FUEL REMOVAL-PREP/LIC.
FUEL POOL "A"-ENG/PREP/MODS
PLENUM REMOVAL TOOLING-ENG./FAB/TEST
FUEL REMOVAL TOOLING-ENG./FAB/TEST
FAFR CANS/RACKS-ENG./FAB/INST
PLENUM REMOVAL/INSPECTION
PLENUM CUT/DISPOSAL
R.V. FUEL & FUEL DEBRIS REMOVAL
CORE MATERIAL INVENTORY
CSA REMOVAL-PREP.
CSA REMOVAL TOOLING-ENG./FAB.
CSA REMOVAL
DECONTAMINATION
REACTOR DISASSEMBLY & DEFUELING
DATA ACQUISITION/PLANNING SUPPORT
COMPL. PART A DOSE REDUCTION
COMPL. PH.1 '82
COMP. PH.1 RVSG.D-RINGS
DOSE REDUCTION/GROSS & HANDS ON DECON
MAINTAIN AREAS PREVIOUSLY DECONNED
GROSS/HANDS ON DECON
MAINTAIN AREAS PREVIOUSLY DECONNED
BLDG & SYS. STABILIZATION
VOLUME RED. CAPABILITY
43
INITIAL
FINAL
47
COMPL. FUEL SHIPPING
42 COMPL. SOLID R/W OPS
46 COMPL. LIQUID R/W OPS
57 COMPL. PLANT STAB/SAFETY
45 COMPL. VOL. REDUCTION OPS
DATA ACQUISITION; TECH PLANNING SUPPORT
31 PR TOOLING
32 FR TOOLING
INSP. UNDERSIDE OF HEAD, RAD. MEASUREMENTS, PROCEDURES & LIC.
37 START CORE MAT'L INVENTORY
PROVIDE VACUUM SYS DES, PROC & INST
PREP SER, PROVIDE CCTV, SERV. & INSTR. AIR & POWER
REACTOR MOCKUP 20
START CAN DEL.
REM/STORE R.V. HEAD 25
47 START FUEL SHIPMENT
47 COMPL. FUEL SHIPPING
DEVELOP SYSTEM & IMPLEMENT
DECONTAMINATION/DEFUELING PROGRAM COMPLETE
LEGEND:
START OR FINISH OF WORK ACTIVITY
ACTIVITY COMPLETED
MILESTONE
RESTRAINT INDICATES THE DEPENDENCY OF ONE WORK ACTIVITY ON ANOTHER
16 RESTRAINT FROM ANOTHER ACTIVITY TO LINE 16
16 RESTRAINT FROM LINE 16 TO ANOTHER ACTIVITY
KEY RECOVERY ACTIVITY
REV. NO.
DATE
REMARKS
BY
CHKD
APPR.
GPU Nuclear Corp.
GENERAL PUBLIC UTILITIES NUCLEAR
THREE MILE ISLAND UNIT 2
TMI-2 RECOVERY PROGRAM
ESTIMATE SCHEDULE
Level 2
JOB NO.
TMI-2
SCHEDULE NO.
PSS-001
SHEET
1 OF 2
REV


SCHEDULE DESCRIPTION
YR.
QTR.
LINE NO.
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
RV HEAD REMOVED
PLENUM REMOVED
START FUEL REMOVAL
START FUEL SHIPPING
START RCS DECON
COMPL. FUEL SHIPPING
RADIOACTIVE WASTE MANAGEMENT
RADWASTE MANAGEMENT SUPPORT
SOLID RADWASTE OPERATIONS
VOLUME REDUCTION FACILITIES
EQUIP.& MAT'L.R/W STAGING FACILITIES
VOLUME REDUCTION OPERATIONS
LIQUID RADWASTE OPERATIONS
FUEL MAT'L.SHIPMENT & DISPOSAL
CONTAMINATED COMPONENT SHIPMENT & DISPOSAL
GENERAL RECOVERY FACILITIES/SYSTEMS
CACE - ENG./PROC./CONST.
CRSB - ENG./PROC./CONST.
PAF - ENG./PROC./CONST.
RESPIRATOR CLEANING FAC.
SUPPORT SYSTEMS
PLANT STABILIZATION/SAFETY
PLANT STABILIZATION/SAFETY
SOLID RADWASTE PROCESSING, PACKAGING, HANDLING ON-SITE STAGING, SHIPMENT & DISPOSAL
LIQUID RADWASTE PROCESSING & ON-SITE STAGING/LIQUID RADWASTE FACILITIES EVALUATION
PLANT OPERATIONS, MAINTENANCE & ENGINEERING
DECISION POINT
CASK CONTAINMENT DEC. PT.
START FUEL REMOVAL
12
AFHB SYS DECON
11
FINAL IN-RV RCS DECON
14
15
FINAL SYS DECON
16
FINAL SYS DECON
37
COMPL. CORE MATERIAL INVENTORY
36
DECISION POINT
DECONTAMINATION/DEFUELING PROGRAM COMPLETE
FINAL SYS DECON
15
LEGEND:
START OR FINISH OF WORK ACTIVITY
ACTIVITY COMPLETED
MILESTONE
RESTRAINT INDICATES THE DEPENDENCY OF ONE WORK ACTIVITY ON ANOTHER
16 RESTRAINT FROM ANOTHER ACTIVITY TO LINE 16
16 RESTRAINT FROM LINE 16 TO ANOTHER ACTIVITY
KEY RECOVERY ACTIVITY
REV NO.
DATE
REMARKS
BY
CHKD
APPR
GPU Nuclear Corp.
GENERAL PUBLIC UTILITIES NUCLEAR
THREE MILE ISLAND UNIT 2
TMI-2 RECOVERY PROGRAM
ESTIMATE SCHEDULE
LEVEL 2
JOB NO.
SCHEDULE NO.
SHEET
REV
TMI-2
PSS-001
2 OF 2
F

TMI-2 RECOVERY PROGRAM ESTIMATE
SCHEDULE MILESTONE TABULATION

TABLE 2

CASE I

	July 1981 Recovery Reevaluation Schedule (RRS-1)	December 1982 Recovery Program Estimate Schedule (PSS-001)
Complete Part A R. B. Dose Reduction	Not Addressed	Mar. 83
Complete Reactor Building Hands-On Decon	Aug. 86	Mar. 88
Polar Crane Requalification Testing Complete	Sep. 83	Mar. 83
Reactor Head Removed	Dec. 83	Jun. 83
Reactor Plenum Removed	Feb. 84	Oct. 84
Start Reactor Fuel & Debris Removal	May 84	Jan. 85
Complete Fuel & Debris Removal	Feb. 85	Jun. 86
Start Reactor Coolant System Decon	Feb. 85	Jul. 86
Complete CSA Removal	Jul. 85	Dec. 86
Complete Reactor Coolant System Decon	Apr. 85	Mar. 87
Start Reactor Fuel Shipping	Aug. 84	Apr. 85
Completion of Phase II Decon	Aug. 86	Mar. 88
Complete Fuel Shipping	Not in Scope	Dec. 87
Final Decon	Not in Scope	May. 88
Complete Radwaste Shipping	Not in Scope	Jun. 88

TMI-2 RECOVERY PROGRAM ESTIMATE
PROGRAM/DEPARTMENTAL CASH FLOW

CASE I

TABLE 3
($ in millions)

Year	Mgmnt.	Recovery Programs	Site Operations		Technical Planning	Licensing SRG/RA	Government & Industry	Support Divisions	'83 Total	Escalation Factor	Escalated Total
			A*	B**							
1983	1.0	28.0	14.3	2.7	4.0	3.0	.9	22.1	76.0	Base	76.0
1984	1.0	48.0	9.9	1.3	2.5	3.0	.9	26.0	92.6	1.08	100.0
1985	1.0	53.6	9.2	4.4	2.0	3.0	.8	26.0	100.0	1.1664	116.6
1986	.8	54.2	8.0	8.5	1.0	3.0	.5	24.0	100.0	1.2597	126.0
1987	.8	63.0	4.5	9.9	.3	1.0	.5	20.0	100.0	1.3605	136.0
1988	.5	22.4	2.1	19.7	--	.5	--	10.0	55.2	1.4693	81.1
Sub-Total	5.1	269.2	48.0	46.5	9.8	13.5	3.6	128.1	523.8		635.7
	Add Cost Through 12/82										339.0
										Total	974.7

* Site Operations "A" = Operations and maintenance activities in support of recovery and as required to meet license conditions.
** Site Operations "B" = Operations activities in support of high level waste shipping and disposal.

DEFINITION OF WBS SECTIONS OF TABLES 4 THROUGH 6

WBS-1 PROGRAM SUPPORT

This activity provides general support services for all of the program organizations. These services include Technical Services, Radiological and Environmental Controls, Communication Services, Nuclear Assurance, Program Management, and External Agency and Committee Support.

WBS-2 DOSE REDUCTION, STABILIZATION AND DECONTAMINATION

These activities will be directed to ensure that the plant is stable and to minimize the personnel exposure during operations in the contaminated areas.

To accomplish the above, contaminated areas must first be characterized. In general, this includes the Reactor Building, the Auxiliary and Fuel Handling Building, and the Reactor Systems. The decontamination of these areas is planned to occur in three phases: Phase I being a gross decontamination, or first cut, Phase II being the attainment of planned decontamination levels and Phase III the maintenance of contamination levels achieved in Phase II.

WBS-3 REACTOR DISASSEMBLY AND DEFUELING

The reactor disassembly and defueling activities are all those that are directly related to removal of the reactor head, internals and fuel from the pressure vessel.

Several major tasks will be required preparatory to the actual reactor dismantling and defueling. These include: under head characterization, polar crane refurbishment, missile shield relocation, canal cleaning and modification, fuel pool modification and the design and procurement of special tools and equipment.

WBS-4 RADIOACTIVE WASTE MANAGEMENT

During the disassembly, defueling, and decontamination operations, contaminated wastes must be managed. This activity includes the planning and operations for managing these wastes. These wastes will generally be liquids, solids and fuel.

Waste operations include processing, packaging and handling, temporary staging and shipping and disposal.

Another significant effort is the separation of the fuel and fuel debris from the water and sludge presently in the facility. When achieved, the fuel will be placed in canisters, stored in the spent fuel storage pool, placed in casks and shipped to a DOE facility.

Concurrent with these waste management activities, appropriate quality assurance inspections, reviews and licensing activities will be performed as required to ensure the technical merit of the activities and the quality of work performed.

WBS-5 GENERAL RECOVERY FACILITIES/SYSTEMS

This activity includes those tasks directed toward providing those facilities and systems required for the support of all decontamination and defueling operations. These tasks include the engineering, planning, and construction of facilities and support systems for containment entry, general recovery, and administrative support.

WBS-6 PLANT STABILITY AND SAFETY

This activity consists of those tasks required to maintain the TMI-2 plant in a safe and stable condition to ensure employee and public health and safety. These tasks include the procurement and installation of special systems, certain plant operations required for safety, plant engineering, and plant maintenance.

TMI- 2 RECOVERY PROGRAM ESTIMATE
SUMMARY CASH FLOW BY WBS/ORGANIZATION
($ x 1000)

CASE I

TABLE 4

WBS	Description	1983	1984	1985	1986	1987	1988	Total
1	Program Support	37547	39318	39345	36127	29249	14032	195618
2	Decontamination	5333	13096	7839	16592	48514	14515	105889
3	Reactor Disassembly & Defueling (RD&D)	14359	15278	23972	19232	2040	3453	78334
4	Radioactive Waste Management	5352	8860	10400	20828	16990	22111	84541
5	General Recovery Facilities/Systems	1199	8157	9995	1548			20899
6	Plant Stability/Safety	12222	7930	8462	5671	3174	1037	38496
	TOTAL	76012	92639	100013	99998	99967	55148	523777
Organization								
	Management	1000	1000	1000	800	800	500	5100
	Recovery Programs	28026	48023	53595	54219	62967	22349	269179
*	Site Operations "A"	14283	9893	9238	7964	4516	2099	47993
**	Site Operations "B"	2704	1323	4380	8515	9884	19700	46506
	Technical Planning	3999	2500	2000	1000	300		9799
	Licensing/SRG/RA	3000	3000	3000	3000	1000	500	13500
	Government & Industry	900	900	800	500	500		3600
	Support Divisions	22100	26000	26000	24000	20000	10000	128100
	TOTAL	76012	92639	100013	99998	99967	55148	523777

* Site Operations "A" = Operations and maintenance activities in support of recovery and as required to meet license conditions.

** Site Operations "B" = Operations activities in support of high level waste shipping and disposal.

TMI-2 RECOVERY PROGRAM ESTIMATE
CASH FLOW DETAIL BY WBS/ORGANIZATION
($ x 1000)

CASE I

TABLE 5

PSS-001 Schedule Line	Description	1983	1984	1985	1986	1987	1988	Total
1	Program Support							
	Recovery Programs	7080	6240	6240	6240	6240	2840	34880
	Site Operations A	1597	1433	1366	1187	409	192	6184
	Licensing	3000	3000	3000	3000	1000	500	13500
	Technical Planning	1870	745	939	400	300		4254
	Site Management	1000	1000	1000	800	800	500	5100
	Government & Industry	900	900	800	500	500		3600
	Other Divisions/G&A	22100	26000	26000	24000	20000	10000	128100
TOTAL WBS 1		37547	39318	39345	36127	29249	14032	195618
3	Decon Planning/Assistance/Phase III							
	Technical Planning	824	667	470	247			2208
	Site Operations A	56	51	51				158
	Recovery Programs	178	116	116	72			482
4	RB Decon Planning							
	Recovery Programs	7						7
5	AFHB Decon Planning							
	Recovery Programs	7						7
	Technical Planning	73						73
6	Systems Decon Planning							
	Recovery Programs	39						39
	Technical Planning	106						106
7	RB Phase I & II Decon							
	Recovery Programs	1574	4514	840	5550	7660	4430	24568
	Site Operations A	207	193					400
8	RB Phase III Decon							
	Recovery Programs	50	2480	2480	2480	5200	2065	14755
	Site Operations A	90	96					186
9	AFHB Decon Phase I & II							
	Recovery Programs	1630	1200	1200	3100	8700	2740	18570
	Site Operations A	111	96	241				448
10	AFHB Decon Phase III							
	Recovery Programs	30	2200	2200	2200	11740	4280	22650
	Site Operations A	90	96	241				427

TMI-2 RECOVERY PROGRAM ESTIMATE
CASH FLOW DETAIL BY WBS/ORGANIZATION

($ x 1000)

CASE I

(TABLE 5 CONT'D)

PSS-001 Schedule Line	Description	1983	1984	1985	1986	1987	1988	Total
13	Systems Decon General Preparation							
	Recovery Programs	49	477					526
	Site Operations A	2						2
11	Auxiliary & FHB System Stabilization							
	Recovery Programs	210	910					1120
12	Auxiliary & FHB System Deocn							
	Recovery Programs				1000	4885		5885
	Site Operations A				743			743
14,15	Decon RCS & Other CTMT Systems							
	Recovery Programs				1200	10329		11529
16	Final System Decon							
	Recovery Programs						1000	1000
TOTAL WBS 2		5333	13096	7839	16592	48514	14515	105889
18	RD&D Support							
	Recovery Programs	1053	878	878	549			3358
	Technical Planning		426	201	111			738
	Site Operations A	113	134	110	83			440
19	Auxiliary Crane							
	Recovery Programs	426						426
20	Reactor Mockup							
	Recovery Programs	1596						1596
21	Polar Crane							
	Recovery Programs	404						404
22	Remove Missile Shields and Requalify PC							
	Recovery Programs	322						322
23	Underhead Characterization							
	Recovery Programs	610						610
	Technical Planning	170						170
24	Head Removal							
	Recovery Programs	1300						1300

TMI-2 RECOVERY PROGRAM ESTIMATE
CASH FLOW DETAIL BY WBS/ORGANIZATION
($ x 1000)

CASE I

(TABLE 5 CONT'D)

PSS-001 Schedule Line	Description	1983	1984	1985	1986	1987	1988	Total
25	Remove & Store RV Head							
	Recovery Programs	901					1000	1901
26,27	Transfer Canal Modifications							
	Recovery Programs	2230	5290					7520
	Technical Planning	100						100
28,29	Plenum/Fuel Removal Preparation							
	Recovery Programs	2244	914					3158
	Technical Planning	150	106					256
30	Fuel Pool "A" Eng./Prep./Mod.							
	Recovery Programs	590	1428					2018
	Technical Planning	150						150
31,32	Plenum/Fuel Removal Tooling							
	Recovery Programs	1493	1700					3193
33	PAFR Cans/Racks							
	Recovery Programs	102	1707					1809
34,35	Plenum Removal/Disposal							
	Recovery Programs	405	2095			820	1200	4520
36	Fuel Removal							
	Recovery Programs			18700	15056			33756
37	Core Material Inventory							
	Recovery Programs		400	400	400	400	453	2053
38	Core Support Assembly (CSA) Removal Preparation							
	Recovery Programs			1050	2090			3140
39,40	CSA Removal Tooling & Removal							
	Recovery Programs		200	2633	943	820	800	5396
TOTAL WBS 3		14359	15278	23972	19232	2040	3453	78334

TMI-2 RECOVERY PROGRAM ESTIMATE
CASH FLOW DETAIL BY WBS/ORGANIZATION
($ x 1000)

CASE I

(TABLE 5 CONT'D)

PSS-001 Schedule Line	Description	1983	1984	1985	1986	1987	1988	Total
41	Radwaste Management Support							
	Recovery Programs	405	1101	471	179			2156
	Technical Planning	556	556	390	242			1744
42	Solid Radwaste Operations							
	Recovery Programs	800	1010	1008	1008	1008	1008	5842
	Site Operations A	514	572	771	472	408	870	3607
	Site Operations B	2704	1323	1055	1065	609	100	6856
48	Contaminated Equipment Ship/Disposal							
	Site Operations A				1200			1200
	Site Operations B				3600	3000		3000
46	Liquid Radwaste Operations							
	Recovery Programs	32	1178	1180				2390
	Site Operations A	341	1900	325	762			3328
	Site Operations B			2500	2500	1300		6300
43,44,45	Volume Reduction Facilities & R/W Staging Facility							
	Recovery Programs		1220	1600	8000	5165		15985
	Site Operations B					3400	3600	7000
47	Fuel Material Shipping							
	Recovery Programs						533	533
	Site Operations A			275	450	525		1250
	Site Operations B			825	1350	1575	16000	19750
TOTAL WBS 4		5352	8860	10400	20828	16990	22111	84541
50	Containment Air Control Envelop							
	Recovery Programs	258						258
51	Containment Recovery Service Bldg.							
	Recovery Programs		4101	6580				10681
52	Personnel Access Facility							
	Recovery Programs		960	319				1279
53	Respirator Cleaning Facility							
	Site Operations	300						300
54	Support Systems							
	Recovery Programs	641	3096	3096	1548			8381
TOTAL WBS 5		1199	8157	9995	1548			20899

TMI-2 RECOVERY PROGRAM ESTIMATE
CASH FLOW DETAIL BY WBS/ORGANIZATION
($ x 1000)

CASE I

(TABLE 5 CONT'D)

PSS-001 Schedule Line	Description	1983	1984	1985	1986	1987	1988	Total
57	Plant Stability/Safety							
	Recovery Programs	1360	2608	2604	2604			9176
	Site Operations A	10862	5322	5858	3067	3174	1037	29320
TOTAL WBS 6		12222	7930	8462	5671	3174	1037	38496

CATEGORY CHARACTERIZATION FOR TMI-2 PLANNED WORK

Category	Description
Ia	The activities required to maintain the shutdown damaged reactor in a safe condition and efforts necessary to insure public and worker health and safety. This category includes operation in compliance with the plant's technical specifications and support activities that are common to any nuclear facility, such as security, quality assurance and administrative functions. The Category Ia scope of activities also includes efforts essential to maintaining a viable organization to fulfill fundamental requirements of our NRC license.
Ib	The activities that are required to maintain the ability to pursue cleanup work including those necessary to respond to concerns about conditions at TMI. While these activities contribute to being able to clean up the plant, they do not make any net progress on accomplishing that cleanup.
II	The activities that contribute towards making progress on cleanup.

TMI-2 RECOVERY PROGRAM ESTIMATE
CATEGORY OF FUNDS
TO GO $ BY ORGANIZATION/WBS
($ in Millions)

TABLE 6

WBS	DESCRIPTION/ORGANIZATION	I-A	I-B	TOTAL I	II	TOTAL
1	Program Support					
	Recovery Programs		8.0	8.0	26.9	34.9
	Site Operations A	3.6	2.6	6.2		6.2
	Licensing	6.8		6.8	6.7	13.5
	Technical Planning				4.2	4.2
	Onsite Management	2.0	3.1	5.1		5.1
	Government & Industry				3.6	3.6
	Other Divisions/G&A	40.0	20.0	60.0	68.1	128.1
S/T		52.4	33.7	86.1	109.5	195.6
2	Decontamination					
	Recovery Programs				101.1	101.1
	Site Operations A				2.4	2.4
	Technical Planning				2.4	2.4
S/T					105.9	105.9
3	Reactor Disassembly & Defueling					
	Recovery Programs				76.5	76.5
	Site Operations A				.4	.4
	Technical Planning				1.5	1.5
S/T					78.4	78.4
4	Radioactive Waste Management					
	Recovery Programs				26.9	26.9
	Site Operations A				9.4	9.4
	Site Operations B				46.5	46.5
	Technical Planning				1.7	1.7
S/T					84.5	84.5
5	General Support Facilities/Systems					
	Recovery Programs				20.6	20.6
	Site Operations A				.3	.3
S/T					20.9	20.9
6	Plant Stability/Safety					
	Recovery Programs	4.6		4.6	4.6	9.2
	Site Operations A	24.6		24.6	4.7	29.3
S/T		29.2		29.2	9.3	38.5
TOTAL		81.6	33.7	115.3	408.5	523.8

ALTERNATIVES
APPENDIX A

The following pages summarize the cash flow changes and the major schedule changes that result from utilization of the various levels of cash availability assumptions outlined in the introduction. The exhibits in the body of this report are those generated by the Case I assumptions. The following exhibits are summarizations of cash flow and schedule milestones generated by each of the other level-of-cash availability assumptions starting with Case II.

In developing the case studies of various funding alternatives, we assessed the impact of the funding limits on the overall program schedule.

In all cases, the activity relationships established by the program estimate sequence logic were maintained. Milestone date changes were accomplished through dollar allocation to reduce activity durations (multi-shift vs. single-shift) and commence activities earlier that were restrained only by cash flow.

For Cases I, II, and III, the schedule for activities on the critical path to starting fuel removal are the same. In Case III, extra cash flow was assumed to be available (approximately $20.0MM) in 1985 to shorten the fuel removal duration from 18 to 12 months. This is accomplished by performing work on a multiple-shift basis.

In the cash flow scenarios for Case IV and V, the activities on the critical path to starting fuel removal are shortened by applying extra cash flow to them as required to expedite the start of fuel removal by 6 months. In Case V, additional money was assumed to be available to reduce the fuel removal cycle from 18 months to 12 months.

In all cases studied, the time associated with the design, procurement, fabrication, delivery, and installation of major tools and equipment from the time of this report through the first quarter of 1984 limits the improvement of the fuel removal cycle.

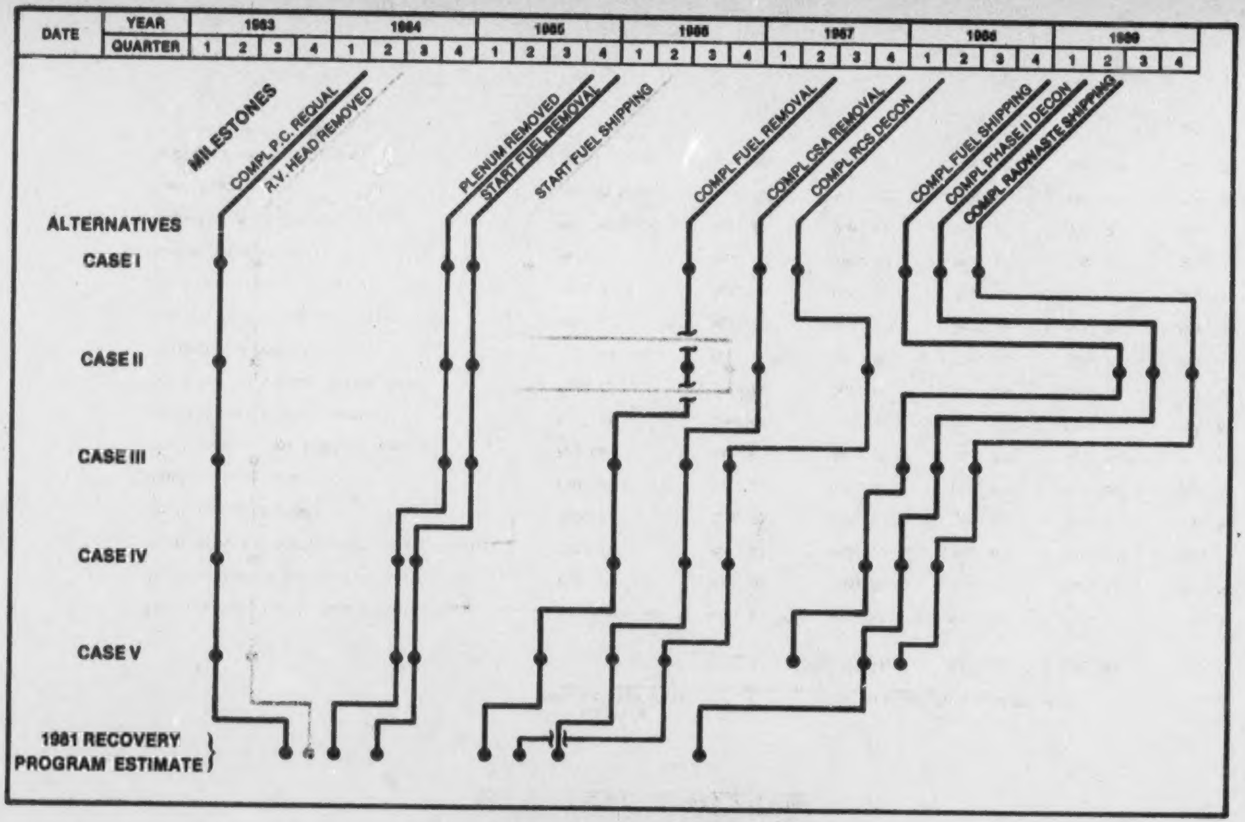
Final decontamination activities and program completion in all cases is dependent upon the completion of fuel canister removal from the fuel pool. In Cases I & III, the cash flow available following completion of fuel removal is approximately the same, resulting in a forecast program completion date of June, 1988. In Case II, which utilitizes the lowest yearly cash flow, the forecast program completion date is extended to December, 1989. The increased monies in Cases IV and V are primarily applied to activities required to accelerate program completion. This results in a forecast program completion date of March, 1988 in Case IV and December 1987 in Case V.

TMI-2 RECOVERY PROGRAM ESTIMATE
PROGRAM ESTIMATE COMPARISON

TABLE 7

	TOTAL ($ Millions) Escalated	TO GO ($ Millions) 1983 Dollars	PROGRAM COMPLETION
July '81	1034.0	644.8	August 86
Case I	974.7	523.8	June 88
II	1041.3	553.6	December 89
III	971.2	525.5	June 88
IV	961.7	520.8	March 88
V	949.6	520.1	December 87

Note: Projected expenditures through December 31, 1982 are $339 Million.



TMI-2 1982 RECOVERY PROGRAM ESTIMATE
SCHEDULE MILESTONE COMPARISON
FIGURE 3

TMI-2 RECOVERY PROGRAM ESTIMATE
SCHEDULE MILESTONES TABULATION

TABLE 8

	JULY 1981 PROGRAM ESTIMATE	DECEMBER 1982 PROGRAM ESTIMATE				
		CASE I	CASE II	CASE III	CASE IV	CASE V
Complete Part A R. B. Dose Reduction	Not Addressed	Mar. 83	Mar. 83	Mar. 83	Mar. 83	Mar. 83
Complete Reactor Building Hands-On Decon	Aug. 86	Mar. 88	Jun. 89	Mar. 88	Dec. 87	Sep. 87
Polar Crane Requalification Testing Complete	Sep. 83	Mar. 83	Mar. 83	Mar. 83	Mar. 83	Mar. 83
Reactor Head Removed	Dec. 83	Jun. 83	Jun. 83	Jun. 83	Jun. 83	Jun. 83
Reactor Plenum Removed	Feb. 84	Oct. 84	Oct. 84	Oct. 84	Jun. 84	Jun. 84
Start Reactor Fuel & Debris Removal	May 84	Jan. 85	Jan. 85	Jan. 85	Jul. 84	Jul. 84
Complete Fuel & Debris Removal	Feb. 85	Jun. 86	Jun. 86	Dec. 85	Dec. 85	Jun. 85
Start Reactor Coolant System Decon	Feb. 85	Jul. 86	Jul. 86	Jan. 86	Jan. 86	Jul. 85
Complete CSA Removal	Jul. 85	Dec. 86	Dec. 86	Jun. 86	Jun. 86	Dec. 85
Complete Reactor Coolant System Decon	Apr. 85	Mar. 87	Aug. 87	Oct. 86	Oct. 86	May 86
Start Reactor Fuel Shipping	Aug. 84	Apr. 85	Oct. 86	Apr. 85	Jan. 85	Sep. 84
Completion of Phase II Decon	Aug. 86	Mar. 88	Sep. 89	Mar. 88	Dec. 87	Sep. 87
Complete Fuel Shipping	Not in Scope	Dec. 87	Jun. 89	Dec. 87	Sep. 87	Mar. 87
Final Decon	Not in Scope	May 88	Nov. 89	May 88	Feb. 88	Nov. 87
Complete Radwaste Shipping	Not in Scope	Jun. 88	Dec. 89	Jun. 88	Mar. 88	Dec. 87

TMI-2 RECOVERY PROGRAM ESTIMATE
PROGRAM/DEPARTMENTAL CASH FLOW

CASE II

TABLE 9

($ in millions)

Year	Mgmt.	Recovery Programs	Site Operations		Technical Planning	Licensing SRG/RA	Government & Industry	Support Divisions	'83 Total	Escalation Factor	Escalated Total
			A*	B**							
1983	1.0	28.0	14.3	2.7	4.0	3.0	.9	22.1	76.0	Base	76.0
1984	1.0	48.0	9.9	1.3	2.5	3.0	.9	26.0	92.6	1.08	100.0
1985	1.0	43.0	8.9	1.0	2.0	3.0	.8	26.0	85.7	1.1664	100.0
1986	.8	42.2	6.4	1.5	1.0	3.0	.5	24.0	79.4	1.2597	100.0
1987	.8	41.6	4.7	4.6	.3	1.0	.5	20.0	73.5	1.3605	100.0
1988	.5	37.7	4.3	7.8	.3	.5	--	17.0	68.1	1.4693	100.0
1989	.5	33.7	4.0	7.3	.3	.5	--	16.0	62.3	1.5868	98.9
1990	--	--	--	16.0	--	--	--	--	16.0	1.7137	27.4
Sub-Total	5.6	274.2	52.5	42.2	10.4	14.0	3.6	151.1	553.6		702.3
	Add Cost Through 12/82										339.0
										Total	1041.3

* Site Operations "A" = Operations and maintenance activities in support of recovery and as required to meet license conditions.

** Site Operations "B" = Operations activities in support of high level waste shipping and disposal.

TMI-2 RECOVERY PROGRAM ESTIMATE
PROGRAM/DEPARTMENTAL CASH FLOW

CASE III

TABLE 10

($ in millions)

Year	Mgmt.	Recovery Programs	Site Operations A*	Site Operations B**	Technical Planning	Licensing SRG/RA	Government & Industry	Support Divisions	'83 Total	Escalation Factor	Escalated Total
1983	1.0	28.0	14.3	2.7	4.0	3.0	.9	22.1	76.0	Base	76.0
1984	1.0	48.0	9.9	1.3	2.5	3.0	.9	26.0	92.6	1.08	100.0
1985	1.0	69.6	9.2	4.5	2.0	3.0	.8	30.0	120.1	1.1664	140.1
1986	.8	52.9	8.0	9.8	1.0	3.0	.5	24.0	100.0	1.2597	126.0
1987	.8	63.9	3.7	9.8	.3	1.0	.5	20.0	100.0	1.3605	136.0
1988	.3	6.8	2.9	18.4	.1	.3	--	8.0	36.8	1.4693	54.1
Sub-Total	4.9	269.2	48.0	46.5	9.9	13.3	3.6	130.1	525.5		632.2
	Add Cost Through 12/82										339.0
										Total	971.2

* Site Operations "A" = Operations and maintenance activities in support of recovery and as required to meet license conditions.
** Site Operations "B" = Operations activities in support of high level waste shipping and disposal.

TMI-2 RECOVERY PROGRAM ESTIMATE
PROGRAM/DEPARTMENTAL CASH FLOW

CASE IV

TABLE 11

($ in millions)

Year	Mgmt.	Recovery Programs	Site Operations A*	Site Operations B**	Technical Planning	Licensing SRG/RA	Government & Industry	Support Divisions	'83 Total	Escalation Factor	Escalated Total
1983	1.0	37.0	14.3	2.7	4.0	3.0	.9	23.1	86.0	Base	86.0
1984	1.0	56.0	9.9	1.3	2.5	3.0	.9	28.0	102.6	1.08	110.8
1985	1.0	51.8	9.6	5.8	2.0	3.0	.8	26.0	100.0	1.1664	116.6
1986	.8	55.7	7.7	7.3	1.0	3.0	.5	24.0	100.0	1.2597	126.0
1987	.8	59.3	5.2	12.9	.3	1.0	.5	20.0	100.0	1.3605	136.0
1988	.2	8.7	1.3	16.5	--	.5	--	5.0	32.2	1.4693	47.3
Sub-Total	4.8	268.5	48.0	46.5	9.8	13.5	3.6	126.1	520.8		622.7
	Add Cost Through 12/82										339.0
										Total	961.7

* Site Operations "A" = Operations and maintenance activities in support of recovery and as required to meet license conditions.

** Site Operations "B" = Operations activities in support of high level waste shipping and disposal.

TMI-2 RECOVERY PROGRAM ESTIMATE
PROGRAM/DEPARTMENTAL CASH FLOW

CASE V

TABLE 12

($ in millions)

Year	Mgmnt.	Recovery Programs	Site Operations A*	Site Operations B**	Technical Planning	Licensing SRG/RA	Government & Industry	Support Divisions	'83 Total	Escalation Factor	Escalated Total
1983	1.0	35.0	14.3	2.7	4.0	3.0	.9	25.1	86.0	Base	86.0
1984	1.0	62.4	10.5	6.3	2.5	3.0	.9	30.0	116.6	1.08	125.9
1985	1.0	60.1	10.1	12.9	2.0	3.0	.8	30.0	119.9	1.1664	139.9
1986	.8	54.9	6.8	9.0	1.0	3.0	.5	24.0	100.0	1.2597	126.0
1987 (12 mo.)	.8	54.6	4.4	16.0	.3	1.0	.5	20.0	97.6	1.3605	132.8
Sub-Total	4.6	267.0	46.1	46.9	9.8	13.0	3.6	129.1	520.1		610.6
	Add Cost Through 12/82										339.0
										Total	949.6

* Site Operations "A" = Operations and maintenance activities in support of recovery and as required to meet license conditions.
** Site Operations "B" = Operations activities in support of high level waste shipping and disposal.

RECONCILIATION
APPENDIX B

This section reconciles the change in cost between this Recovery Program Estimate (Revision 2) and the prior Estimate (Revision 1, dated July, 1981). Included here is a brief description of the basis for the reconciliation estimate, a reconciliation summary by WBS category, and details of reconciliation items.

Reconciliations by work categories A through K are also presented. It is important to note that these figures are based upon estimates of how various WBS activities would fit into the A through K categories and not upon an independent development of costs by those categories.

TMI-2 RECOVERY PROGRAM ESTIMATE
RECONCILIATION BASIS

		ADJUSTMENTS $X1000	TOTAL $X1000
1.	Total July '81 cost estimate in 1980 Base $		819,423
	Refer to Page 30 of the TMI-2 Recovery Program Estimate (Revision 1, July 1981). The total cost estimate of $1,034,326 minus escalation costs of $214,903 equals the above base amount.		
2.	Delete actual (deescalated to 1980 values) for the historical years 1979 through 1980		(323,026)
A.	Delete actuals expended through 1980 See Page 30 of the July '81 estimate	(214,401)	
B.	Delete actual expenditure for 1981 deescalated to 1980 value. ($58,718K deescalated by 10%)	(53,830)	
C.	Delete estimated expenditure for 1982 8 + 4 forecast = $65,700K deescalated by 10% for 1981 and 9% for 1982	(54,795)	
3.	Total 1980 $ value of the To Go Work Scope		496,397
4.	Escalate the To Go Work Scope to 1983 Base $		148,422
	This step completes the calculations (except rounding) required to bring the estimated to go scope of the July '81 estimate up to a common base with this estimate. Escalation is applied at the same percentage as was used in the July '81 estimate for 1983. (from pg. 30 of the July '81 estimate 45346/151458 = 29.9%		
5.	Rounding		(19)
6.	Total '83 Comparable		644,800

On the above basis, the total program costs were tallied according to the program WBS categories, and the differences between this estimate and the 1981 estimates for each category were calculated. These values are summarized in Table 13, and detailed in Table 14.

TMI-2 RECOVERY PROGRAM ESTIMATE
RECONCILIATION
SUMMARY
WBS

TABLE 13

WBS Level 2	Description	July '81 Program Estimate $ x 1000	December '82 Program Estimate $ x 1000	Change $ x 1000
1	Program Support	248590	195618	(52972)
2	Decontamination	78850	105889	27039
3	Reactor Disassembly & Defueling	27980	78334	50354
4	Radioactive Waste Management	94190	84541	(9649)
5	General Recovery Facilities/ Systems	54480	20899	(33581)
6	Plant Stability/Safety	140710	38496	(102214)
TOTAL		644800	523777	(121023)

TMI-2
RECOVERY PROGRAM ESTIMATE
RECONCILIATION DETAIL

TABLE 14

July 1981 Estimate (To Go Total in 1983 $)

WBS NO.	DESCRIPTION RECONCILIATION ITEM	ITEM $ x 1000	TOTAL $ x 1000 644,800
1	PROGRAM SUPPORT		(52972)
	A. Exclude Technical Planning costs shifted from WBS Section 1 to both WBS Sections 2 and 3.	(3800)	
	B. Exclude costs for Outside Contractors to BNoC shifted from WBS Section 1 to WBS Section 3	(15070)	
	C. Decrease in amount of Engineering and other nonmanual costs which have not been allocated to the other direct WBS sections. The amount of Engineering (etc.) costs unallocated in the '81 estimate is $53.3M with escalation to 1983 value = $69.2M. The equivalent amount included in this estimate = $37.7M.	(31500)	
	D. Miscellaneous	(2602)	
2	DECONTAMINATION		27039
	A. Increase in manual hours for decon activities in the AFHB estimate. 1.27 million hours x $30.5/hr = $38.7 million. "'81" assessment included = $5.0M after 1982 for AFHB Decon with escalation $5.0M = $6.5M.	32200	
	B. Add prorated value for nonmanual contribution now included in AFHB Decon estimates; = 225K hours at $28.0/hr = $6.3M.	6300	
	C. Containment Building decon hours decrease from those in the '81 estimate, (419K hours x $30.5/hr = $12.8M).	(12800)	
	D. Decrease in nonmanual hours associated with Item "C" above at 20% = 84K hours x $28/hr = $2.4M.	(2400)	
	E. Include Technical Planning for these activities. In the '81 estimate, all Technical Planning (BNI) was included in WBS Section 1.	2390	
	F. Allowance for decontamination activities on the reactor vessel head.	1000	
	G. Miscellaneous	349	

TMI-2
RECOVERY PROGRAM ESTIMATE
RECONCILIATION DETAIL

(TABLE 14 CONT'D)

WBS NO.	DESCRIPTION RECONCILIATION ITEM	ITEM $ x 1000	TOTAL $ x 1000
3	REACTOR DISASSEMBLY & DEFUELING		50354
	A. Include costs for Outside Contractors to BNoC - primarily B&W with minor Burns & Roe - previously included in WBS Section 1 $11.6 escalated to '83.	15070	
	B. Increase in RD&D manual manhour estimate = 392K hours x $30.5/hr (includes distributable material as included in wage rate).	12000	
	C. Increase in Direct Material estimate 1981 estimate escalated to 1983 value = $14.7M current estimate = $21.1M.	6400	
	D. Added allowance for provision of a second fuel transfer tube and transfer mechanism.	2700	
	E. Include Technical Planning for these activities. In the '81 estimate, all Technical Planning (BNI) was included in WBS Section 1.	1410	
	F. Wage rate adjustment. Increased allowance for distributable material purchases included within the wage rage development.	2500	
	G. Include estimate for Research and Development activities which assist in Reactor Disassembly and Defueling.	4200	
	H. Miscellaneous	6074	
4	RADWASTE MANAGEMENT		(9649)
	A. Added estimate for fuel shipment costs. Excluded from '81 estimate.	21000	
	B. Delete the '81 estimate to go costs for Evaporator/Solidification Facility $19.5M escalated to 1983 value.	(25300)	
	C. Add the estimate costs for the Volume Reduction Facility and additional equipment and material Radwaste Staging Facility.	15955	
	D. Add costs for operating the Volume Reduction Facility and for disposal of the waste generated by this process.	7000	

TMI-2
RECOVERY PROGRAM ESTIMATE
RECONCILIATION DETAIL

(TABLE 14 CONT'D)

WBS NO.	DESCRIPTION RECONCILIATION ITEM	ITEM $ x 1000	TOTAL $ x 1000
	E. Delete the '81 estimate inclusion for Volume Reduction Incinerator $5.8M escalated to 1983 value.	(7500)	
	F. Delete the '81 estimate inclusion for Evaporator/Incinerator waste storage and operations. 1. Incinerator is excluded. 2. Evaporator costs are in Items C & D above. $7.6 million escalated to 1983 value.	(9900)	
	G. Interim Liner Storage Facility Modules C through F no longer in estimate. $6.0 million escalated to '83 value.	(7900)	
	H. Allowance for shipment of miscellaneous equipment and components removed from radiation areas as part of dose reduction activities.	7900	
	I. Allowance for operations and waste handling costs estimated with increased processing of refueling canal/fuel pool water.	7600	
	J. Site Operations Solid & Liquid Radwaste Operations packing and handling. '81 estimate = $15.9 million escalated = $20.7 million. (See operations in RRS-1 lines 5, 7, 9, 10, 70, 74) current estimate = $12.0 million.	(8700)	
	K. Equipment & Material Radwaste Staging Facility (now included in WBS 5 account) $2.1 million escalated to '83 value.	(2730)	
	L. Miscellaneous	(7074)	
5	GENERAL RECOVERY FACILITIES/SYSTEMS		(33581)
	A. Containment Recovery Service Bldg. '81 estimate escalated $10.7M. Reassessment $9.1M.	(1600)	
	B. Hot Chem Lab (Replaced by mobile Radiochemical labs to date.)	(1900)	
	C. Processed Water Storage System '81 estimate escalated $4.4M. current estimate $3.0M.	(1400)	

TMI-2
RECOVERY PROGRAM ESTIMATE
RECONCILIATION DETAIL

(TABLE 14 CONT'D)

WBS NO.	DESCRIPTION RECONCILIATION ITEM	ITEM $ x 1000	TOTAL $ x 1000
	D. Site Upgrade & Support Facilities '81 estimate escalated $15.3M. current estimate $3.5M.	(11800)	
	E. Laundry Facility/Respirator cleaning. In the current estimate laundry is handled as a contract by Site Operations. The respirator cleaning facility remains.	(9300)	
	F. Temporary Systems/Facilities Removal '81 estimate escalated $13.0M current estimate (temporary systems only) $2.0M.	(11000)	
	G. Miscellaneous	3419	
6	PLANT STABILITY/SAFETY		(102214)
	A. Add Recovery Programs contribution to perform miscellaneous small repairs and normal housekeeping activities.	9000	
	B. Decrease in Cold Iron Operations & Maintenance from $15.0 million/year from '83 to '86 which = $60.0 million escalated to '83 dollars = $78.0M. Current estimate Cold Iron Operations & Maintenance = $30.8M.	(47200)	
	C. Delete the preventative maintenance and layup activities which were included in the '81 estimate and have since been stopped. Corrective & preventative maintenance remain for the recovery plant. Delete allowance for to go costs in '81 estimate of $46.7M with escalation = $60.7M.	(60700)	
	D. Miscellaneous	(3314)	
	TMI-2 RECOVERY PROGRAM ESTIMATE (To Go Total in 1983 $)		523777

TMI-2 RECOVERY PROGRAM ESTIMATE RECONCILIATION BASIS BY CATEGORIES A THROUGH K

Category	July '81 Estimate (1980 $) $MM	Delete July '81 Estimate of 1982 Costs (1980 $) $MM	Add 1982 Actuals $MM	Deescalate 1982 Actuals to 1980 $ $MM	Total 1980 $ to go as of 1/83 $MM	Total '83 Comparable with 29.9% escalation $MM
A	41	(14)	14	(2)	39	51
B	21	(7)	8	(1)	21	27
C	16	(10)	11	(2)	15	19
D	25	(22)	6	(1)	8	10
E	84	(21)	1		64	84
F	63	(4)	15	(3)	71	93
G	63	(10)	11	(2)	62	82
H	9	(3)			6	8
I	110	(7)			103	135
J	30				30	39
K	13				13	17
Sub Total	475	(98)	66	(11)	432	565
Base O&M	75	(15)	Inc. above	Inc. above	60	80
TOTAL	550	(113)	66	(11)	492	645

DEFINITION OF CATEGORIES FOR TABLE 15

MAINTAINING PLANT IN SAFE CONDITION

A. Operation of Plant in Safe Shutdown Condition while fuel is in the reactor - This category includes the operation of existing plant systems and equipment required to maintain the core in a safe condition. Plant engineering, plant chemistry staff support, associated consumable materials, Associated Construction Management, and Radiological Control efforts until core removal are also included.

B. Site Support Services other than Plant Operations while fuel is in the reactor - This category includes all site support services not directly associated with any specific construction end-product or operating facility. These support items include such diverse efforts as Construction Accounting, Quality Assurance and Quality Control operations, Procurement, Contracts, Warehousing, Training, Security, Industrial Health & Safety Insurance, Word Processing, Computer Software and hardware support, Document Control, Taxes, etc. until core removal.

C. Decontamination of Auxiliary Building and Contaminated Water Inventory - This activity includes the operation of the following Waste Processing Facilities: EPICOR II and Laundry, and associated waste disposal costs. The final decontamination of the Auxiliary Building, tanks and tank farm, Submerged Demineralizer System and staging tanks, Decay Heat Vaults and Mini-Decay Heat System are also included. Engineering and construction of additional Interim Liner Staging Modules, associated construction Management and Radiological Control efforts for all items listed above have also been assigned to this category.

D. Processing of highly contaminated water in the Containment Building and Reactor Coolant System - This category includes the engineering and construction of additional processed water storage tanks and additional Interim Liner Staging Modules, the continued operation of the Submerged Demineralizer System, which was installed in 1981, and the associated disposal of SDS wastes. Also included are associated Construction Management and Radiological Control support activities.

ADDITIONAL COST TO DEFUEL REACTOR AND CONTAINMENT DECONTAMINATION

E. Additional facilities required to decontaminate the Containment Building - This category includes the Engineering and Construction of the following new facilities: Evaporator/Solidification Facility, Volume Reduction Incinerator, Hot Chemistry Laboratory, Containment Recovery Service Building, Command Center/Temporary Personnel Access Facility, simplified Personnel Access Facility, Laundry Facility, Site Upgrading and Support Facilities. Also included are the engineering, consultant, Project and Construction Management resources required to design and construct the above listed facilities.

F. Gross decontamination of the Containment Building to permit fuel removal - This category includes the installation costs for gross decontamination support systems and associated manual labor to accomplish gross decontamination procedures necessary to permit effective manpower utilization for fuel removal operation. Also included are the allocated costs associated with the operation of the laundry facilities, waste storage and disposal operations, decontamination facilities operation and specialized decontamination equipment. Support services from Radiological Controls, Project Management and Construction Management are also incorporated in this category.

G. Head and Core Removal - This category includes engineering, consultant and direct manual labor associated with the removal of the reactor head and internals as well as dismantling and inspection of the core and transfer of the fuel elements to the fuel pool. Adjustments to the fuel pool storage area, associated shielding as well as support services from Radiological Controls, and Project and Construction Management are also included.

H. Facilities required to temporarily house containment equipment and material removed from the Containment Building - This category includes engineering, consultant and direct manual labor and materials to construct the Equipment and Material Radwaste Staging Facility. Also included are associated Project and Construction Management Services and direct labor to operate this facility.

I. Additional decontamination of the Containment Building and removal of contaminated equipment and material; including associated waste operations - This category includes the installation costs for additional decontamination support systems and associated manual labor to accomplish final, detailed, decontamination of the Containment Building required prior to the start of reconstruction or decommissioning activities. Also included are the associated waste processing, staging, shipping and disposal costs as well as support services from Radiological Controls, Project and Construction Management.

J. Operation of Plant after fuel is removed from reactor - This category includes the operation of plant systems and equipment during the interval when there is no fuel in the reactor. Plant Engineering, Plant Chemistry and Radiological Control supporting these operations are also included.

K. Site Support Services other than Plant Operations and Maintenance after fuel is removed from reactor - This category includes all site support services not directly associated with any specific construction end-product or operating facility. These overhead items include such diverse efforts as Construction Accounting, Quality Assurance and Quality Control operations, Procurement, Contracts, Warehousing, Training, Security, Industrial Health and Safety, Insurance, Word Processing, Computer software and hardware support, Document Control, Taxes, etc.

TMI-2 RECOVERY PROGRAM ESTIMATE
RECONCILIATION SUMMARY
CATEGORIES A THROUGH K

TABLE 15

CATEGORY	DESCRIPTION	JULY '81 PROGRAM ESTIMATE $MM	DEC. '82 PROGRAM ESTIMATE $MM	CHANGE $MM
MAINTAINING PLANT IN SAFE CONDITION				
A.	Operation of existing and modified plant systems and equipment required to maintain the core in a safe condition. Includes operating personnel, support staff and consumable supplies until core removal.	51	36	(15)
B.	Site support services, other than the operating staff noted above required to support site activities but not directly associated with and specific construction end-product or operating facility. These support services include security, QA/QC, procurement, warehousing, accounting, training, industrial health & safety, etc. until core removal.	27	26	(1)
C.	Decontamination of auxiliary building and contaminated equipment and processing of auxiliary & fuel handling building contaminated water. Includes operating personnel, radiological control staff, and contractor personnel required to operate the associated waste processing systems and laundry facilities; construction of interim waste staging facilities and associated waste disposal.	19	78	59
D.	Processing of highly contaminated water in the containment building and reactor coolant system. Includes installation and operation of associated water processing systems and additional waste staging capability.	10	9	(1)
	Subtotal (A-D)	107	149	42
ADDITIONAL COST TO DEFUEL REACTOR FOR CONTAINMENT DECONTAMINATION				
E.	Additional facilities required to decontaminate the containment building. Includes design & construction of evaporator/solidification facility, hot chemistry lab, containment recovery service building, personnel access facility, laundry, etc.	84	63	(21)
F.	Gross decontamination of the containment building to permit fuel removal operations to proceed within acceptable radiological limitation. Includes installation of decontamination support systems, shielding and manual, supervisory and support personnel for decontamination operations	93	76	(17)

TMI-2 RECOVERY PROGRAM ESTIMATE
RECONCILIATION SUMMARY
CATEGORIES A THROUGH K

TABLE 15
(CONT'D)

CATEGORY	DESCRIPTION	JULY '81 PROGRAM ESTIMATE $MM	DEC. '82 PROGRAM ESTIMATE $MM	CHANGE $MM
G.	Head and core removal. Includes engineering, consultant and direct labor associated with technical preparation, removal of reactor head and internals, dismantling, inspection and transfer of core to fuel pool.	82	119	37
H.	Additional facilities required to temporarily house contaminated equipment and material removed from the containment building. Includes the engineering design and construction of additional radwaste staging facilities, solid and liquid	8	3	(5)
I.	Additional decontamination of the containment building and removal of contaminated equipment and materials to staging areas. Includes the operation of associated decontamination, waste packaging, processing and disposal operations.	135	92	(43)
J.	Operation of existing plant systems after damaged core is removed from reactor until completion of decontamination. Includes operating personnel, support staff and consumable supplies.	39	10	(29)
K.	Site support services, other than the operating staff noted above, required to support site activities but not directly associated with any specific construction end-product or operating facility during interval between removal of damaged core until completion of decontamination.	17	12	(5)
	Subtotals (E-K)	458	375	(83)
	Grand Total (A-K)	563	524	(41)
	Base Plant O&M	80	0	(80)
	TOTAL PROJECT	645	524	(121)

Mr. OTTINGER. What about new reactors? There are not an awful lot of orders for them at the moment in this country. Are you planning these more efficient reactor designs for new reactors and hope to sell them in the future?

Dr. JACOBI. I would like to take a crack at that one. Westinghouse initiated what we call our advanced PWR program internally 4 years ago. We signed agreements with Japanese associates to do this work jointly, perhaps 18 months ago. It is a very active development program. It utilizes a mechanical spectral shift type of reactor design to improve the neutron economy and the uranium utilization. That is going forward very actively. We have a very real concern that we do not see an opportunity to demonstrate that in the United States, and its first incarnation will most likely be in Japan. We are working with U.S. utilities to get their input into the design and help us determine the design features they want. It is our hope that when the market returns, and we also think it will, we will see that type of reactor in the United States.

Mr. OTTINGER. My next question may be a little bit off the subject, and I have used more time than I should, but I am very curious. If we are having all these problems with reactors around the country, with corrosion of the pipes, do you see in future reactors solutions to that leakage problem? It is causing problems in my area and in a number of other places.

Dr. JACOBI. We would make one point, that we have a very major internal program working on those issues that you speak of, but I am not aware of its details.

Mr. OTTINGER. Thank you, Mr. Chairman.

Mr. HALL. Mr. Ottinger, thank you. Are there other questions from any of the panel?

[No response.]

Mr. HALL. If not, I want to wind up with a question. You know everything gets down to the cash register, and I think one of you, maybe Dr. Jacobi, estimated a $12 million funding level for activity to continue the present program, and I think DOE has indicated to our staff that the figure is closer to $8 million. That is, according to my mathematics, 20 to 30 percent off. What is the differentiation there? What caused it?

Dr. JACOBI. If there is a differentiation, I would mention that we are this year concluding one program with DOE, examining fuel which has come out of the Surry reactor at burnups of 43,000. We have proposed and negotiated with DOE a similar program, also jointly with the utilities, on our optimized fuel assembly, which has not been executed as yet because of the funding constraints on the program. That is why I spoke of the new contractual authority, and we would very much like to see that go forward. Perhaps that is the difference between the DOE estimate and our own.

Mr. HALL. That is the $4 million?

Dr. JACOBI. We could not account for all of that. We could account for much of it, though.

Mr. HALL. We thank you, gentlemen.

Our next witness will be Mr. Robert C. Arnold, who is president of the GPU Nuclear Corp. Mr. Arnold, we are delighted to have you with us here today. You, as others, might summarize your testimony or stay with your written statement. Your written statement will be made a matter of record. If you would, Mr. Arnold, please proceed.

STATEMENT OF ROBERT C. ARNOLD, PRESIDENT AND CHIEF OPERATING OFFICER, GPU NUCLEAR CORP., MIDDLETOWN, PA., ACCOMPANIED BY BAHMAN K. KANGA, DIRECTOR, UNIT 2, THREE MILE ISLAND; AND JOHN G. GRAHAM, TREASURER, GENERAL PUBLIC UTILITIES CORP., PARSIPPANY, N.J.

Mr. **Arnold**. Thank you very much, Mr. Chairman. I am prepared to offer a summary of my filed testimony. Before I proceed, I would like to introduce Mr. Bahman Kanga, who is on my right, and who has joined me here today. Mr. Kanga is the director of TMI-2, and as such he reports to me with responsibility for all TMI-2 activities regarding the cleanup and safe conditions at the plant.

I am Robert C. Arnold. I am president of GPU Nuclear Corp. I would, first of all, like to thank you for the opportunity to state my views on the Department of Energy's research and development programs at Three Mile Island.

The DOE has been a constant and important source of technology and specialists, serving as an industrial clearinghouse for both requirements. The DOE technical information and examination program was established to take advantage of the unique opportunities at TMI-2, to gather information for the advancement of light water reactor safety, reliability, regulation, and operation.

The postaccident condition of the damaged plant provides unprecedented opportunities to acquire information of benefit to nuclear power technology. Various technical information and examination program elements, I think, can best be grouped for purpose of discussion into three categories, that of data acquisition, reactor evaluation, and waste immobilization.

In the data acquisition area, specific areas of interest include instrumentation and electrical system assessment, radiation and environment, and offsite core examination. Coming out of this total aspect of the program, the most important one was indicated on the tape that was shown this morning, that of the decontamination experiment, which has shown consistent and signficant reductions in smearable levels of contamination in the reactor building when the appropriate sequence and application of techniques is utilized.

The second category, the reactor evaluation program, has two major areas of investigation: Core and reactor internals characterization and reactor disassembly and damaged core removal technology development. The objective of the core and reactor internals characterization is to characterize the condition of the TMI-2 core and reactor internals. The core design improvements aimed at mitigating the consequences of severe fuel damage could be identified through characterization of our core in its present condition. In terms of the disassembly and damaged core removal technology, the inspection that will be made under this program element will provide confirmation on the degree of damage to the upper internals and to the core by identifying fuel and core component debris that may have been deposited in the plenum area and by providing information on component conditions. This task will advance the state-of-the-art of early core damage assessment and will support reactor disassembly and defueling.

Within the reactor evaluation program, there have been two significant accomplishments to date. The first one is that of movement of what we call axial power-shaping rods. They are rods that are not inserted at the time of shutdown but are in a fixed position during operation, and the program was successful in determining electrical and mechanical conditions of the control rod drive mechanisms as part of that element of the test program.

The tape also described the project we call Quick Look, which was the examination of the internals of the reactor, giving us our first look at the core.

In the third program area of waste immobilization, there have been three principal aspects of that: The disposition of the zeolite materials that were used in one of the cleanup systems, which again was discussed in the tape, the disposition of the resin materials that were utilized in the other cleanup system, what was referred to in the tape as EPICOR-II, and finally, the disposition of abnormal waste and their handling.

I think that we have seen very substantial progress on the waste immobilization program. To date, five of the seven highly loaded stainless steel containers of zeolite resins have been shipped from the site, and we anticipate that the balance will be shipped by the latter part of this year. There were very substantial technology developments realized in the course of preparing those materials for shipping, including how to successfully control radiolytic generation of gases and the project also included similar considerations with regard to the 50 EPICOR-II prefilters. Of those 50, as of today, 30 have been shipped off the site, with the remaining 20 scheduled for shipment offsite by the end of third quarter of this year.

We recently completed, as part of the ongoing effort to understand ourselves and share with others the scope of the TMI-2 program, a reassessment of the total defueling and decontamination effort. This was an update of a program estimate that was made in mid-1981, and we did have additional technical information available for this update. We also have a better understanding, I think, of the prospects for funding the program, and those elements were reflected in the assumptions that were utilized for conducting the assessment.

The assessment indicates a completion date slippage from the 1981 forecast of approximately 2 years. The 1981 forecast, though, was based upon unlimited funding. However, the removal of the damaged fuel from the unit 2 reactor could begin in 1985 and be completed during 1986, approximately the timeframe projected by the 1981 estimate. This fact is important since core removal has been identified as the next major milestone on the path to minimizing risk to public health and safety resulting from the accident.

In fiscal year 1983 and beyond, our activities anticipate steady progress on the cleanup activities, and that expectation is to a very major extent based upon the availability of resources to support pursuit of reactor core removal and disposal. DOE, through its research program, has proven to be a valuable contributor of such resources. Completion of two tasks, the polar crane testing and the reactor vessel head removal, projected to occur in DOE fiscal year 1983, will meet two key major milestones on the critical path to core removal and disposal.

GPU Nuclear is anticipating continued technical information and examination program involvement at TMI-2 in fiscal year 1984 to assist in maintaining progress. We will accomplish this progress through the utilization of DOE resources for activities that are prerequisites to core removal and disposal. Most of these prerequisite activities fall within the program element I described as reactor evaluation.

A major near-term milestone will be the removal of the reactor vessel head, currently scheduled for mid-1983, and the removal of the reactor vessel plenum will follow that in early fiscal year 1985. Design, fabrication, and assembly of a defueling test assembly which we can use to field test and prepare tooling for both the reactor plenum assembly and core removal operations is anticipated. We will be installing a fuel transfer canal cleaning system to take advantage of the shielding properties associated with water. Plenum assembly removal and subsequent core removal will be performed in a flooded transfer canal. The canal cleaning system will provide the means for maintaining water clarity, which is vital to both underwater plenum and fuel removal. The canal cleaning system will have the capacity to filter suspended fine particles of fuel which we anticipate will be present in that water. Removal of these fuel fines will contribute toward our goal of a reactor-building environment with the lowest practical worker dose rates.

Preparations for core removal are scheduled to commence late this fiscal year and will extend into early fiscal year 1985. Other activities in progress at TMI-2 deal with tooling required for the plenum removal, the waste disposal canisters into which the fuel will go, the canister racks that must be provided at the site for interim storage prior to shipment, and modifications to the transfer equipment necessary to transfer those canisters from the reactor building to the fuel handling building for eventual shipment.

As stated previously, we are both in pursuit of and are planning to pursue activities to achieve core removal disposal as expeditiously as resources allow. DOE's involvement in TMI-2 has contributed significantly. We are hopeful they will continue to contribute resources to support these efforts, while at the same time insuring that some of the unique and very valuable information to be obtained from the accident is not forever lost.

Thank you, Mr. Chairman. We would be happy to address any questions you may have.

[The prepared statement of Mr. Arnold follows:]

I am Robert C. Arnold, President of GPU Nuclear Corporation (GPUNC), and I would like to thank you for the opportunity to state my view of the Department of Energy's (DOE) research and development programs at Three Mile Island. The DOE has been a constant and important source of technology and specialists, serving as an industry clearing house for both requirements.

The DOE Technical Information and Examination Program (TI&EP) was established to take advantage of the unique opportunities at TMI-2 to gather information for the advancement of light water reactor safety, reliability, regulation and operation. The post-accident condition of the damaged plant provides unprecedented opportunities to acquire information of benefit to nuclear power technology.

The various TI&EP elements are grouped into two sub-programs: 1) Data Acquisition, and 2) Waste Immobilization and Reactor Evaluation. However, for this discussion, I would like to summarize the status of these efforts for you in three sections: 1) Data Acquisition, 2) Reactor Evaluation, and 3) Waste Immobilization.

1. DATA ACQUISITION

Specific areas of interest include instrumentation and electrical system assessment, radiation and environment, and off-site core examination.

Instrumentation and Electrical

The primary work of the I&E task is to assess the survivability and current condition of reactor building instrument, electrical and cable system components and to inform the nuclear power industry of any findings with the potential for improving current reliability or safety.

Radiation and Environment

The purpose of the radiation and environment task is to obtain, analyze and distribute pertinent information associated with fission product transport and deposition, decontamination and personnel dose reduction and accident evaluation.

Offsite Core Examination

The off-site core examination will contribute to understanding the nature and extent of the TMI-2 accident and its effects on reactor fuel and core material.

THE MOST SIGNIFICANT ACCOMPLISHMENT WITHIN THE DATA ACQUISITION PROGRAM HAS BEEN:

The Decontamination Experiment

The experiment has shown that consistent significant reductions in smearable levels are achievable with the appropriate sequence and application of techniques. These data are the first comprehensive documentation of gross decontamination in a commercial reactor facility.

2. REACTOR EVALUATION PROGRAM

The program has two major areas of investigation: Core and reactor internals characterization, and reactor disassembly and damaged core removal technology development.

Core and Reactor Internals Characterization

The objective of this task is to characterize the condition of the TMI-2 core and reactor internals. Core design improvements aimed at mitigating the consequences of severe fuel damage accidents could be identified through characterization of the TMI-2 core and reactor internals.

Reactor Disassembly and Core Removal Technology Development

This inspection will provide confirmation on the degree of damage to the upper internals and to the core by identifying fuel and core component debris that may have been deposited in the plenum area and by providing information on component conditions. This task will advance the state-of-the-art of early core damage assessment and will support reactor disassembly and defueling.

THE SIGNIFICANT ACCOMPLISHMENTS WITHIN THE REACTOR EVALUATION PROGRAM HAVE BEEN:

Axial Power Shaping Rod Test

The TMI-2 APSR insertion tests were successful in determining the electrical and mechanical condition of the control rod drive mechanisms.

Quick Look

These inspections provided the first visual information on the condition of the core and upper reactor internals and was of significant interest to both researchers and recovery planners.

3. WASTE IMMOBILIZIATION PROGRAM

The program has three major areas of interest: zeolite disposition, resin disposition and abnormal wastes.

Zeolite Disposition

The objective of the zeolite disposition task is to provide for the shipment and disposition of the SDS wastes from TMI-2.

Resin Disposition

Further knowledge concerning solidification of resins, resin degradation, radionuclide behavior in the environmental media and efficiency of a high integrity container should be valuable to the development of new low-level radioactive waste disposal facilities.

Abnormal Wastes

This task will collect the available information and make available existing DOE technology to develop the specialized techniques required to decontaminate tanks, sumps, coolers and piping systems at TMI-2.

SIGNIFICANT ACCOMPLISHMENTS WITHIN THE WASTE IMMOBILIZATION PROGRAM HAVE BEEN

The shipment of five SDS Ion Exchange Vessels off the TMI site after finding a way to successfully control radiolytic generation of gases, and shipping 30 EPICOR II prefilters off site after implementing a specially designed gas sampling system to ensure safe transport. The TI&EP also directed DOE laboratories in characterization of the purification demineralizers and in experiments to vitrify radioactive waste.

Examples of accomplishments include:

- Characterization of an EPICOR II Resin Prefilter (PF-16)
- Prototype Gas Sampler Development
- Zeolite Vitrification

SUMMARY OF PROGRAM FUNDING AUTHORIZED IN FISCAL YEAR 1983

Some of these activities will continue into Fiscal Year 1984 and beyond.

Data Acquisition - $1.8 million

Reactor Evaluation - $11.7 million

Waste Immobilization - $0.5 million

OVERALL TMI-2 PROGRAM ESTIMATE

We have recently completed an update of the 1981 estimate for the defueling and decontamination of TMI-2.

The target completion date is forecast to have slipped by approximately two years relative to the 1981 forecast which was based upon an assumption of unlimited funding. However, the removal of the damaged fuel from the Unit 2 reactor could still begin in 1985 and be completed during 1986, approximately the time frame projected by the 1981 estimate. This fact is important since core removal has been identified as the next major milestone on the path to minimizing risk to public safety and the environment.

PLANNED ACTIVITIES IN FY '83 AND OUT YEARS

Our steady progress at TMI-2 can be attributed to the availability of resources to support pursuit of reactor core removal and disposal. DOE, through its TI&EP research and development efforts, has proven to be a valuable contributor of such resources. Completion of two tasks, polar crane testing and reactor vessel head removal, projected to occur in DOE Fiscal Year 1983, will meet two key milestones on the critical path to core removal and disposal.

GPU Nuclear is anticipating continued TI&EP involvement at TMI-2 in Fiscal Year 1984 to assist in maintaining progress. We will accomplish this through utilization of DOE resources for activities that are prerequisites to core removal and disposal. Most of these prerequisite activities fall within the Reactor Evaluation Program.

Removal of the reactor vessel plenum assembly in early Fiscal Year 1985.

Design, fabrication and assembly of a defueling test assembly which will be used to field test and prepare tooling for both the reactor plenum assembly and core removal operations.

Fuel transfer canal cleaning system. In an attempt to take advantage of the shielding properties associated with water, plenum assembly removal and subsequent core removal will be performed in a flooded transfer canal. The canal cleaning system will provide the means for water clarification which is vital to both underwater plenum and core removal operations. The canal cleaning system will also have the capacity to filter suspended fuel fines anticipated in canal water after flooding. Removal of such fuel fines will contribute toward our goal of a reactor building environment with the lowest achievable worker dose rates.

Preparations for core removal are scheduled to commence late this fiscal year and extend into early Fiscal Year 1985.

Other activities in progress at TMI-2 deal with tooling required for plenum removal, waste disposal canisters, canister racks and modifications to canister transfer equipment required for core removal and disposal.

As stated earlier, GPUNC is both in pursuit and planning to pursue activities to achieve core removal and disposal as expeditiously as resources allow. DOE's involvement at TMI-2 has contributed significantly. Hopefully, it will continue to contribute resources to support these efforts while at the same time, ensuring that some of the unique and very valuable information to be obtained from the accident is not forever lost.

ROBERT C. ARNOLD

Mr. Robert C. Arnold is the President and Chief Operating Officer of the GPU Nuclear Corporation, a subsidiary of General Public Utilities.

He is a native of Michigan, has an engineering degree from the University of Michigan and served 10 years as a commissioned officer in the U.S. Navy.

GPU Nuclear Corporation is responsible for GPU's Nuclear facilities - Three Mile Island Units 1 and 2 and Oyster Creek.

TESTIMONY
FOR THE
SUBCOMMITTEE ON ENERGY RESEARCH & PRODUCTION
COMMITTEE ON SCIENCE AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES

by

Robert C. Arnold
President
GPU Nuclear Corporation

March 9, 1983

I INTRODUCTION

Chairman Bouquard and Committee Members:

I am Robert C. Arnold, President of GPU Nuclear Corporation (GPUNC), and I would like to thank you for the opportunity to state my view of the Department of Energy's (DOE) research and development programs at Three Mile Island. I would like to provide you with a brief status report on the TMI-2 cleanup program. Before doing so, let me remind us all that the DOE initially responded to the TMI-2 accident the day it happened. It has been a constant and important source of technology and specialists, serving as an industry clearing house for both requirements.

Following the accident four years ago, the badly damaged plant probably represented the most serious radiological situation private industry has ever faced. The reactor buiding was inaccessible and would remain so for well over a year. The auxiliary building was heavily contaminated and in some areas inaccessible also. Equipment that was originally provided to monitor and control plant conditions could not be operated or maintained because of severe surface contamination conditions and radiation levels in the hundreds of rems per hour. Today, while "pockets" of those conditions still exist, they are few in number and the auxiliary building is approaching a radiological condition similar to a normal operating plant.

The accident and its subsequent management produced significant quantities of radioactive water. Various tanks in the auxiliary building contained approximately 500,000 gallons of contaminated water, and were a major source of the high radiation levels. The original construction of TMI-2 had included a facility in which a steam generator decontamination system was to be installed. In the summer of 1979, this facility was adapted to house a portable demineralizer processing system designed to decontaminate the accident-generated water in the auxiliary building. The system uses mixed organic resin beds and derives its name, EPICOR II from the supplier. Over a period of 13 months from November, 1979 to December, 1980, 565,224 gallons of water were processed by EPICOR II. The operation resulted in 43,100 curies of fission products being deposited in 50 resin containers with loading varying from 160 to 2200 curies (including daughter products). Twenty-two more lightly loaded containers (from less than 1 to 63 curies, daughter products included) were also generated. The 22 lightly loaded containers have been shipped to a commercial low-level burial ground in Hanford, Washington. As of today, 30 of the 50 more highly loaded containers had been shipped by the DOE to Idaho National Engineering Laboratory (INEL) for research and development purposes. The remaining 20 also will be shipped to INEL. Two were shipped to Battelle Columbus Laboratories for characterization and experimentation for assessment of best disposal methods. These containers were then shipped to INEL.

The "feed and bleed" cooling of the reactor during the day of the accident and subsequent leakage from the reactor coolant system and other sources in the containment during and after the accident resulted ultimately in the accumulation of over 600,000 gallons of highly contaminated water in the sump and basement of the reactor building to a depth of 8 1/2 feet. Because of the very high radio-cesium concentrations present in this water and the inherent storage and shipping limitations of organic ion exchange media, it was decided in the Fall of 1979 to use zeolite, an inorganic ion exchange medium, for the decontamination of the reactor building water. Since this system is located in the TMI-2 spent fuel pool and uses water for shielding, it became known as the submerged demineralizer system (SDS).

Construction of the SDS began in March, 1980 and was completed in July, 1981 at a construction cost of about $8 million. The reactor building processing campaign began on September 23, 1981 and was completed on March 5, 1982. The result of this processing campaign was the removal of about 320,000 curies from the containment building water and their encapsulation into seven SDS Zeolite Ion Exchange containers. After SDS, final cleansing of this water in the EPICOR system removed another 50 curies now encapsulated in 36 EPICOR II resin containers. Together the SDS and EPICOR II systems have processed over one million gallons of water, and captured over 400,000 curies at an average cost, including disposal of about $80 per curie.

Because of the residual presence of tritium, an isotope of hydrogen that cannot readily be removed from water, the processed water is stored on site in two 500,000 gallon tanks and other smaller tanks. The total curies of tritium is similar to the quantity of tritium from natural and weapons testing sources that is contained in one year's flow of the Susquehanna River. The water is being retained and controlled on site for recycling use during the cleanup so as to minimize the total volume of contaminated, accident-related water, and to minimize public apprehension.

In a July 15, 1981 Memorandum of Understanding with the NRC, DOE agreed to accept responsibility for the transportation, storage and ultimate disposal of the highly loaded SDS containers. To date, five have been removed from the site and the other two are expected to be removed by mid-1983. Interim storage is provided on the site for the EPICOR II liners in a shielded storage facility that has been constructed since the accident, and in the fuel pool for the SDS containers.

The reactor coolant system (RCS) contains 88,000 gallons of water that were contaminated predominantly by cesium and strontium in approximately equal proportions. Immediately after the accident, the radioactivity in the RCS water measured about 300 μCi/ml. In order to reduce the hazards associated with spills of this water and to prepare for removing the reactor vessel head, we have processed the primary reactor coolant water through the SDS in seven "feed and bleed" batches. Our efforts have been successful (along with natural radioactive decay and dilution effects over the intervening three plus years) in reducing the radioactivity in the water to about 7 μCi/ml. Approximately 20,000 curies of cesium and strontium have been immobilized in the process.

The first major step toward gaining access to the damaged reactor was achieved in 1980 with the removal of about 44,000 curies of the noble gas Krypton-85 from the containment building atmosphere. The Company first requested permission in November, 1979 to remove the krypton by venting the containment building to the atmosphere. However, it was not until the NRC had completed an environmental impact statement, the Governor of Pennsylvania had an independent assessment conducted by the Union of Concerned Scientists, and the local Congressman had conducted hearings on the relative merits of alternative approaches including cryogenic trapping, that approval was finally granted on June 12, 1980. The krypton was vented during a two-week period from June 28 to July 11 with no health effects to the public.

The first manned entry into the TMI-2 reactor building was achieved on July 23, 1980 and lasted for 20 minutes. Since then there have been more than 175 entries into the reactor building.

Despite some progress in decontamination, the reactor building remains contaminated to a degree which severely hampers productivity in recovery tasks. The most severely contaminated area is the basement (282-foot elevation). The entry level floor of the reactor building (305-foot elevation), operating floor (347-foot elevation), and polar crane platform near the dome ceiling present much less of a radiation hazard at this time. Because of the contaminated conditions, workers in-containment are required to wear multiple layers of protective clothing and respirators, and to utilize digital dosimeters and other protective measures. As building characterization and decontamination efforts continue to improve in-containment radiological conditions, we can expect such restrictions to be relaxed and productivity to be improved accordingly.

In July and August of last year, three entries were made into the reactor vessel using a remotely operated television device. A small camera, about 1 and 1/4" in diameter, was inserted through control rod penetrations in the reactor vessel head. These "Quick Look" explorations revealed that the extent of core damage is within the range of analytic predictions: namely, in the central region, the upper five feet of the fuel assemblies has been reduced to rubble, at the outer edges of the core the elements are more nearly intact, the underside of the core plenum/fuel hold-down structure does not reveal gross deterioration, and the oxidized zirconium fuel tubes and fractured pellets lie in a visible loose mass. These pictures are providing useful information relative to the reactor disassembly and the type of special tooling that will be necessary to excavate the core.

As we look forward, the next major milestones are reactor vessel head and reactor vessel plenum structure removal. We hope to be able to remove the vessel head by mid-1983. Nevertheless, removal of the core from the reactor vessel will probably not be complete for another three years. The removed core materials, whether rubble or partial elements, will be packaged, transferred to the fuel storage pool, and removed from the site. In April, 1982, the DOE entered into an agreement in principle with GPUNC, which was witnessed by the Commonwealth of Pennsylvania, to accept responsibility for the transportation, storage and disposal of the TMI-2 core.

The post-accident condition of the damaged plant provides unprecedented opportunities to acquire information of benefit to nuclear power technology.

II. DOE's TMI-2 TECHNICAL INFORMATION AND EXAMINATION PROGRAM

The DOE Technical Information and Examination Program (TI&EP) was established to take advantage of the unique opportunities at TMI-2 to gather information for the advancement of light water reactor safety, reliability, regulation and operation.

The various TI&EP elements are grouped into two sub-programs: 1) Data Acquisition, and 2) Waste Immobilization and Reactor Evaluation. However, for this discussion, I would like to summarize the status of these efforts for you in three sections: 1) Data Acquisition, 2) Reactor Evaluation, and 3) Waste Immobilization. In each section I will first address the scope of the activities, then follow with a brief description of significant accomplishments to date.

II A. DATA ACQUISITION

II.A.1 SCOPE

The purpose of the Data Acquisition Program is to obtain information from the TMI-2 accident to improve light-water reactor plant safety, reliability and operability; obtain information from the recovery program for the advancement of technology in decontamination, waste disposal and system requalification; and to disseminate useful information and technological developments from the TI&EP and GPU's recovery program to the nuclear industry.

Specific areas of interest include instrumentation and electrical system assessment, radiation and environment, and off-site core examination.

Instrumentation and Electrical

The proper functioning of instrumentation and electrical (I&E) equipment during and after an accident is critical for control and operation of a plant. The primary work of the I&E task is to assess the survivability and current condition of reactor building instrument, electrical and cable system components and to inform the nuclear power industry of any findings with the potential for improving current reliability or safety. This work is accomplished by extensive in situ testing and by the removal of selected components from the reactor building for detailed tests and analyses at various national or private laboratories and universities.

Data from these analyses should provide government and private agencies, societies, manufacturers, architectural firms and utilities with the technical baseline from which improvements can be made in (a) industry regulations and procedures, (b) system and component location and operation, (c) instrument design and development and (d) equipment configuration and qualification testing under normal, transient and accident conditions.

Techniques developed in this program area have assisted significantly in recovery related activities such as polar crane testing and the location of the APSR's in a position to be uncoupled, a prerequisite to reactor vessel head removal. This program is also investigating incore instrument damage with the intent of defining damage to the portion of the core to which we currently do not have visible access.

Radiation and Environment

The purpose of the radiation and environment task is to obtain, analyze and distribute pertinent information associated with fission product transport and deposition, decontamination and personnel dose reduction and accident evaluation.

The objective of the fission product transport and deposition effort is to acquire data on all fission products released from the core to plant systems, plant environment and outside environment. This includes evaluations of gaseous, liquid and solid samples (including material and surface samples) from the primary system, containment system, the auxiliary systems and the auxiliary building. The results of these samples are used to develop a radionuclide mass balance which can be used to aid in validating current source term models.

The decontamination and personnel dose reduction effort will require the acquisition of data related to state-of-the-art decontamination techniques, personnel beta radiation sensitive dosimetry and advances in field measurement instrumentation. These data will provide the basis for evaluations of suggested techniques, equipment requirements and cost effectiveness.

The primary emphasis of the accident evaluation effort centers on hydrogen burn assessment. Following the TMI-2 accident and the hydrogen burn which occurred in the reactor building, the NRC issued new rules related to hydrogen control systems and equipment survivability. The intent of this activity is to provide information to increase the understanding of the TMI-2 hydrogen burn and to provide aid to the industry in resolving concerns associated with licensing plants under the new NRC rules.

Offsite Core Examination

The off-site examination task supports analysis, characterization, archiving and storage of fuel, core debris samples and nonfuel samples from the TMI-2 accident and cleanup. One of the preliminary activities of this task will be to identify the data to be acquired during in situ and off-site examinations of core materials and to define the type, range and level of accuracy required.

The off-site core examination will contribute to understanding the nature and extent of the TMI-2 accident and its effects on reactor fuel and core material. The data obtained from these analyses will provide information to improve upon or validate current reactor design standards and in development of regulations and safety guidelines.

IIA.2 SIGNIFICANT ACCOMPLISHMENTS

Under the Data Acquisition Program, numerous in-situ tests have been performed in pursuit of its goal to assess instrumentation and equipment survivability. In three areas, incore instrumentation, axial power shaping rods and polar crane work, I&E work supports the progress of the cleanup by gaining information about the damaged core which assists in development of plans for reactor vessel head removal. In other areas, data acquisition tasks have identified failure modes which may lead to improvements in instrumentation and electrical equipment design, installation and maintenance.

A significant accomplishment within the Data Acquisition Program is:

o Decontamination Experiment

The purpose of the decontamination experiment was to determine the effectiveness, safety and efficiency of several gross decontamination techniques. The predominant technique used in the experiment was low- and high-pressure water spraying of floors and walls.

The areas included in the gross decontamination experiment were the reactor building dome, the 500-ton polar crane, the walkways on top of the two D-rings, the refueling canal and the top of the reactor vessel missile shields. Also decontaminated were large tools, equipment and floor surfaces on the operating deck (347-foot elevation) and overhead areas, walls and floors on the entry elevation (305-foot elevation).

The experiment has shown that consistent significant reductions in smearable levels are achievable with the appropriate sequence and application of techniques. These data are the first comprehensive documentation of gross decontamination in a commercial reactor facility.

Pre- and post-experiment data acquisition activities included:

- Placing and collecting of approximately 100 thermoluminescent dosimeters (TLD) at selected reactor building locations
- Obtaining some 200 loose particulate, concrete, metal, cable, and damaged item samples
- Collecting gamma spectrometer measurements
- Measuring contact beta and gamma radiation levels using a portable radiation instrument
- Conducting comprehensive smear surveys
- Collecting air samples
- Performing area photographic characterization surveys.

II B. REACTOR EVALUATION PROGRAM

II.B.1 SCOPE

Results of the nuclear industry review of proposed TI&EP activities at TMI-2 indicated that characterization of the reactor core was of particularly high priority with respect to their concerns.

The purpose of the Reactor Evaluation Program is to determine the nature and extent of fuel and core component damage, and to develop generic technology applicable to the safe defueling of a damaged light water reactor core. The program has two major areas of investigation: Core and reactor internals characterization, and reactor disassembly and damaged core removal technology development.

Core and Reactor Internals Characterization

The objective of this task is to characterize the condition of the TMI-2 core and reactor internals. This task will require data acquisition from the fuel, core components and reactor internals before, during and after core removal, both on-site and at selected off-site facilities. It also involves the development of techniques and equipment necessary to support data acquisition. Core design improvements aimed at mitigating the consequences of severe fuel damage accidents could be identified through characterization of the TMI-2 core and reactor internals.

Reactor Disassembly and Core Removal Technology Development

The objective of this task is to develop generic technology for damage assessment, reactor disassembly and defueling following an accident. This task will require: (a) development of tooling and techniques for early core damage assessment; (b) development of tooling and techniques for core and reactor internals removal; and (c) development of technology for packaging and storage of damaged fuel.

This effort will require the design and development of techniques and equipment to inspect the plenum and upper core area prior to removal of the reactor vessel head. This inspection will provide confirmation on the degree of damage to the upper internals and to the core by identifying fuel and core component debris that may have been deposited in the plenum area and by providing information on component conditions. This task will advance the state-of-the-art of early core damage assessment and will support reactor disassembly and defueling.

II.B.2 SIGNIFICANT ACCOMPLISHMENTS

The Reactor Evaluation Program has made significant progress in characterizing the conditions inside the damaged Unit 2 reactor. These accomplishments provide a sound basis for conducting future defueling operations and also contribute to development of technology for defueling severely damaged light-water reactor cores.

o Axial Power Shaping Rod Test

From June 23 to 25, 1982, DOE and GPUNC combined forces with a number of contractors and support engineering firms to conduct the first axial power shaping rod (APSR) insertion tests at the damaged TMI-2 reactor. The eight 12-ft-long APSRs control efficient use of the fuel during normal plant operations. They are not part of the reactor safety system and, therefore, did not insert automatically into the core at the time of the accident as did the other 61 control rods.

The TMI-2 APSR insertion tests were successful in determining the electrical and mechanical condition of the control rod drive mechanisms. Additional conclusions regarding the condition of reactor internals may also be developed from the sound recording and electrical monitoring devices used in these tests. The APSR test was a significant first step in an extensive inspection and examination program to support planning for safe removal of the fuel from the TMI-2 reactor.

- Quick Look

One of the most significant Reactor Evaluation Program accomplishments was the initial access to the reactor vessel during the "Quick Look" examinations in July and August, 1982. The objective of the these examinations was to inspect control rod guide tubes, portions of the reactor plenum and upper grid, the tops of fuel assemblies and, to the extent possible, the reactor core. These inspections provided the first visual information on the condition of the core and upper reactor internals and was of significant interest to both researchers and recovery planners. The results of the "Quick Look" effort established a significant benchmark from which the projected range of core condition and accident sequence estimates can be narrowed.

- Other Reactor Evaluation Program activities have been equally successful and have made significant progress toward completing preparations for reactor head removal. One task is the inspection of the polar crane, the key component required for lifting the reactor head from the reactor vessel. All polar crane inspections and repairs to the crane have been completed. These repairs, followed by the testing of the crane, should allow the reactor head to be removed in mid-1983, a major milestone in the reactor disassembly sequence.

II.C WASTE IMMOBILIZIATION PROGRAM

II.C.1 SCOPE

The purpose of the Waste Immobilization Program is to: (a) incorporate unique information and technology developed during the TMI-2 cleanup into ongoing government and private waste management programs; (b) provide resources for the near-term transfer of radioactive technology for accident application from TMI-2 to the industry; and (c) perform research and development, and document information and technology of generic value to the nuclear industry in the areas of radioactive waste processing, storage, transportation and disposal. The program has three major areas of interest: zeolite disposition, resin disposition and abnormal wastes.

Zeolite Disposition

The objective of the zeolite disposition task is to provide for the shipment and disposition of the SDS wastes from TMI-2. The basic approach is to provide technical support to GPUNC in preparing the SDS zeolite liners for shipment, provide shipment of the liners to a national laboratory and conduct research and development on zeolite immobilization and disposal.

Resin Disposition

The objectives of the resin disposition task are to: (a) provide for the receipt, handling, interim storage and R&D disposition of EPICOR II system wastes from TMI-2; (b) identify shipping requirements, coordinate shipping schedules for casks and services and establish the interfaces necessary to accomplish safe shipments on schedule; (c) develop a prototype gas sampler for sampling, venting and purging of organic resin liners at TMI-2 while obtaining safety-related data required for safe shipment of EPICOR II prefilters from TMI-2 to a national laboratory; and (d) identify cost effective research and development programs for the disposition of highly loaded EPICOR II resin wastes generated at TMI-2.

The successful disposition of the EPICOR II prefilters will provide the industry with very useful information. Further knowledge concerning solidification of resins, resin degradation, radionuclide behavior in the environmental media and efficiency of a high integrity container should be valuable to the development of new low-level radioactive waste disposal facilities.

Abnormal Wastes

The objective of the abnormal waste task is to provide technical support for the identification and removal of special wastes which cannot be disposed of at a commercial burial ground from TMI-2 and to provide for the safe shipment of these wastes to a national laboratory for research, development and disposition. The short term objective is to provide the necessary technical support for the removal of the TMI-2 purification system demineralizer resins and to identify other potentially abnormal wastes at TMI and classify these wastes per the proposed 10 CFR 61 criteria for commercial land burial.

There has been very little documentation of industry experience and techniques for the removal and decontamination of highly radioactive sludge and debris from systems and components. This task will collect the available information and make available existing DOE technology to develop the specialized techniques required to decontaminate tanks, sumps, coolers and piping systems at TMI-2.

II.C.2 SIGNIFICANT ACCOMPLISHMENTS

Planning and design work initiated in 1981 saw much of its fulfillment during 1982. Significant accomplishments include the shipment of five SDS Ion Exchange Vessels off the TMI site after finding a way to successfully control radiolytic generation of gases, and shipping 30 EPICOR II prefilters off site after implementing a specially designed gas sampling system to ensure safe transport. The TI&EP also directed DOE laboratories in characterization of the purification demineralizers and in experiments to vitrify radioactive waste.

Significant accomplishments within the Waste Immobilization Program are:

- Characterization of an EPICOR II Resin Prefilter (PF-16)

  As part of DOE's research and development program, Battelle Columbus Laboratories completed characterization studies on an organic medium ion exchange used to process contaminated water from the TMI-2 accident.

  The characterization of PF-16 provided researchers with valuable information about the behavior of highly loaded ion-exchange media and yielded baseline data for the development of safe handling, storage and disposal techniques. One of the most important results of this characterization work is the fact that the degradation of ion exchange media, caused by high radioactivity loading, did not result in loss of integrity, or even perceptible damage to the PF-16 steel liner.

- Prototype Gas Sampler Development

  Special tooling to sample gases from highly radioactive EPICOR II ion-exchange media prefilters in the field was developed. The tool is called a prototype gas sampler (PGS). To ensure safe shipment of prefilters from TMI for research and disposition, the PGS was designed to remotely remove and reinstall prefilter vent plugs, capture and sample any gases released and purge prefilters of combustible gases with an inert gas.

  Functional testing at TMI demonstrated the PGS to be effective in venting and inerting EPICOR II prefilters to ensure their safe shipment from TMI. Both the techniques employed and the technical information provided by their use have proven extremely valuable.

- Zeolite Vitrification

On December 31, 1982, DOE shipped the first highly radioactive ion-exchange media vessel from the SDS at TMI Unit-2. The vessel was part of the system that processed more than a half-million gallons of radioactive water from the TMI-2 reactor building where the water accumulated as a result of the March, 1979 accident. DOE shipped this vessel to Battelle Pacific Northwest Laboratories (PNL) at Richland, Washington for testing and disposition research. This shipment followed a highly successful DOE Research and Development Program to devise a catalyst and necessary tooling for its addition to the SDS Ion Exchange Vessels to prevent the formation of combustible gases during transportation and storage.

At PNL three highly loaded vessels underwent experiments on the feasibility of vitrifying the radioactive inorganic ion-exchange media zeolites. In the vitrification process the zeolites and glass-forming chemicals are fed into a canister in a furnace where the mixture is heated to cause vitrification. After the mixture cools, the canister serves as the container for the final waste product, a glass column considered to be a stable form for the SDS zeolite waste. Additional tests with higher radioactivity will establish the technical feasibility of vitrification as a disposition option for TMI-2's more highly loaded radioactive wastes.

III. SUMMARY OF TASKS TO BE PERFORMED UNDER PREVIOUSLY AUTHORIZED FY '83 FUNDING

The following is a summary listing of the significant tasks funded by DOE in Fiscal Year 1983. Some of these activities will continue into Fiscal Year 1984 and beyond. Further details of the planned accomplishments in these areas are addressed in Section V.

Data Acquisition - $1.8 million

1. Removal of Electrical and Cable Samples
2. Purification Demineralizer Information
    a. System to vent and sample contents
    b. Resin samples
    c. Video/photo surveys of cubicles
    d. Radiation/contamination surveys of cubicles
3. Visual Observations of 282' Elevation
4. In-situ Test Program

Reactor Evaluation - $11.7 million

1. Defueling Test Assembly
2. Head Removal Tasks Including Underhead Characterization and Quickscan II
3. Head, Plenum & Fuel Removal Tooling
4. Canal Cleanup Sytem
5. Fuel Canisters and Racks
6. Fuel Transfer Tube Modifications

Waste Immobilization - $0.5 million

1. Characterization of Abnormal Wastes
2. EPICOR Prefilter Radioactive Gas & Containment Assessment
3. Shipment of EPICOR II Prefilters
4. Removal & Disposition of SDS Vessels

IV. OVERALL TMI-2 PROGRAM ESTIMATE

We have recently completed an update of the 1981 estimate for the defueling and decontamination of TMI-2. This revision was based, in large part, on the various technical assumptions and approaches that have evolved in each of the major recovery program areas. Some of these are well established and documented, while some are in the developmental stage. Attachment 1 is a copy of our program estimate and also includes summary information on its contents.

As can be seen from review of the estimate, the target completion date is forecast to have slipped by approximately two years relative to the 1981 forecast which was based upon an assumption of unlimited funding. However, the removal of the damaged fuel from the Unit 2 reactor could still begin in 1985 and be completed during 1986, approximately the time frame projected by the 1981 estimate. This fact is important since core removal has been identified as the next major milestone on the path to minimizing risk to public safety and the environment.

V. PLANNED ACTIVITIES IN FY '83 AND OUT YEARS

Our steady progress at TMI-2 can be attributed to the availability of resources to support pursuit of reactor core removal and disposal. DOE, through its TI&EP research and development efforts, has proven to be a valuable contributor of such resources. Completion of two tasks, polar crane testing and reactor vessel head removal, projected to occur in DOE Fiscal Year 1983, will meet two key milestones on the critical path to core removal and disposal.

In looking ahead, GPU Nuclear is anticipating continued TI&EP involvement at TMI-2 in Fiscal Year 1984 to assist in maintaining progress. We will accomplish this through utilization of DOE resources for activities that are prerequisites to core removal and disposal. Most of these prerequisite activities fall within the Reactor Evaluation Program.

Activities focusing on removal of the reactor vessel plenum assembly in early Fiscal Year 1985 and subsequent core removal are both in progress and planned at TMI-2 and should provide significant information to the research and development effort. Fiscal Year 1984 allocations to TMI-2 will be directed to these activities to ensure that performance occurs as scheduled.

One of these activities is the design, fabrication and assembly of a defueling test assembly which will be used to field test and prepare tooling for both the reactor plenum assembly and core removal operations. It will provide the opportunity for hands-on training of personnel prior to actual performance, a practice which has been proven to significantly reduce worker radiation exposure during actual operations. Design and construction of the assembly is scheduled to start this fiscal year and be completed by early Fiscal Year 1984.

Preliminary design is also currently underway for a fuel transfer canal cleaning system at TMI-2. In an attempt to take advantage of the shielding properties associated with water, plenum assembly removal and subsequent core removal will be performed in a flooded transfer canal. Installation of the canal cleaning system will provide the means for water clarification which is vital to both underwater plenum and core removal operations. The canal cleaning system will also have the capacity to filter suspended fuel fines anticipated in canal water after flooding. Removal of such fuel fines will contribute toward our goal of a reactor building environment with the lowest achievable worker dose rates. Fabrication, installation and field testing of the fuel transfer canal cleaning system will extend well into Fiscal Year 1984.

Other general preparations which directly support plenum assembly removal are also in progress at TMI-2. We are currently in the early preparation phase of determining specific activities that will be required for timely plenum removal. These activities include data acquisition efforts to formulate and verify radiation levels in specific plant locations, coordination of existing plant conditions and specifications with those required for plenum removal, and the determination of regulatory requirements with regard to operating procedures, safety analyses and other documentation. In addition, preliminary design efforts are underway for plenum removal rigging and jacking, support systems to provide required utility service and the establishment of desired shielding configurations and contamination control barriers. These activities will continue into Fiscal Year 1984 to support our reactor plenum assembly removal milestone.

Preparations for core removal are scheduled to commence late this fiscal year and extend into early Fiscal Year 1985. Preparatory activities in this area are along the same lines as those described for plenum removal. Our recent recovery program estimate identified this grouping of core removal preparations as a candidate for acceleration if additional funding becomes available.

The fuel handling building "A" fuel pool refurbishment task is another area of current activity at TMI-2. This fuel pool is the designated location for staging fuel-loaded canisters prior to shipment. Its refurbishment is dependent on the removal of a series of tanks which were temporarily set in the fuel pool and shielded as part of our initial response to the accident. Engineering for the characterization and safe removal of shielding, tankage and associated components began early this fiscal year to support a targeted fuel pool refurbishment completion in mid-to late Fiscal Year 1984. This task is on our critical path to flooding of the transfer canal, and is another candidate for acceleration given the receipt of additional funding.

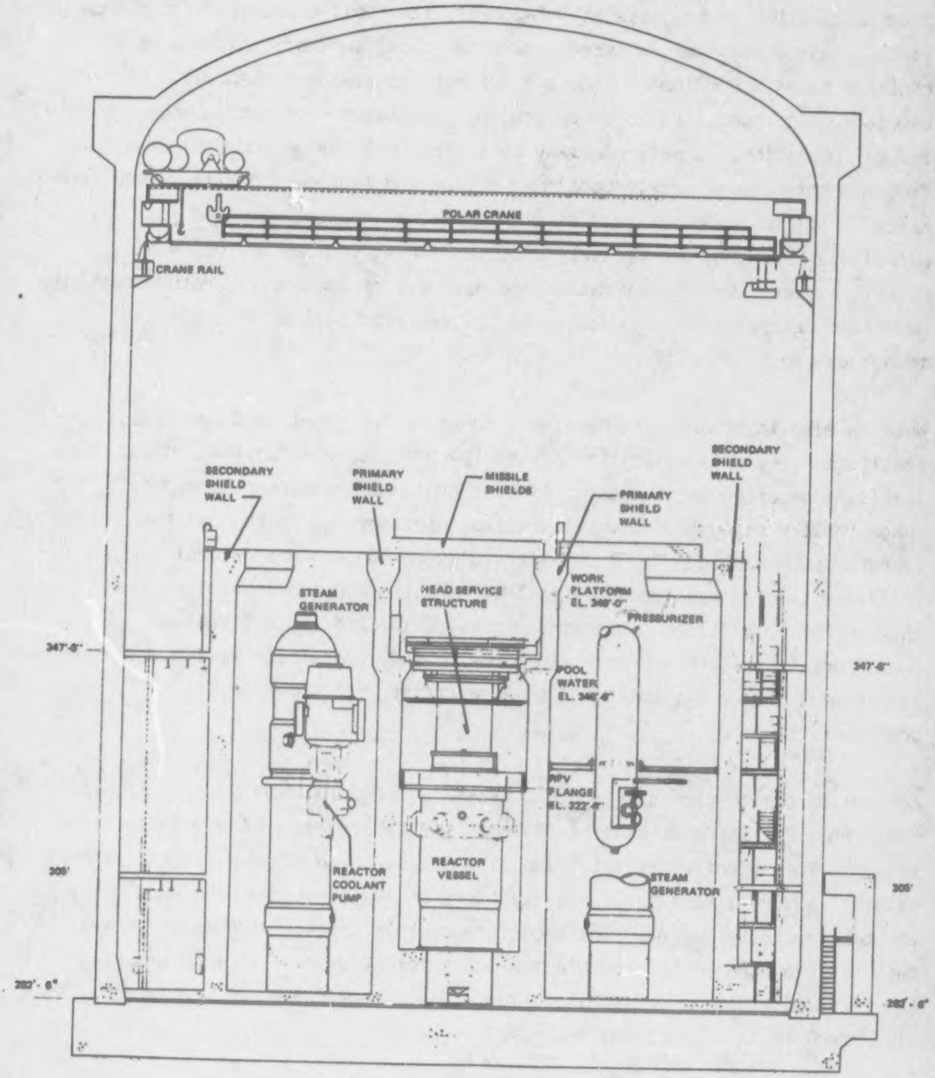
Other activities in progress at TMI-2 deal with tooling required for plenum removal, waste disposal canisters, canister racks and modifications to canister transfer equipment required for core removal and disposal. Development of specifications for tooling associated with both plenum and core removal operations is well underway to allow final design and fabrication to commence this fiscal year. Continued design and fabrication will extend into Fiscal Year 1984 with delivery of plenum removal tooling targeted for mid-Fiscal Year 1984 and delivery of core removal tooling to follow at mid-Fiscal Year 1985. Fabrication and delivery of tooling for both operations have been determined as candidates to be completed earlier if additional resources can be applied.

Work is also in progress to develop dimensions for final canister design and fabrication, as well as preliminary design and ultimate fabrication and installation of canister racks. Careful design is required to ensure compatibility among core removal tooling, canisters racks and canister transfer mechanism components. A carefully controlled dimensional design interface is also required between TMI-2 and the DOE facility designated to receive the core filled canisters to provide for precise offloading operations. Canister and rack final design and fabrication will continue into late Fiscal Year 1984, but could be accelerated with the allocation of additional funding.

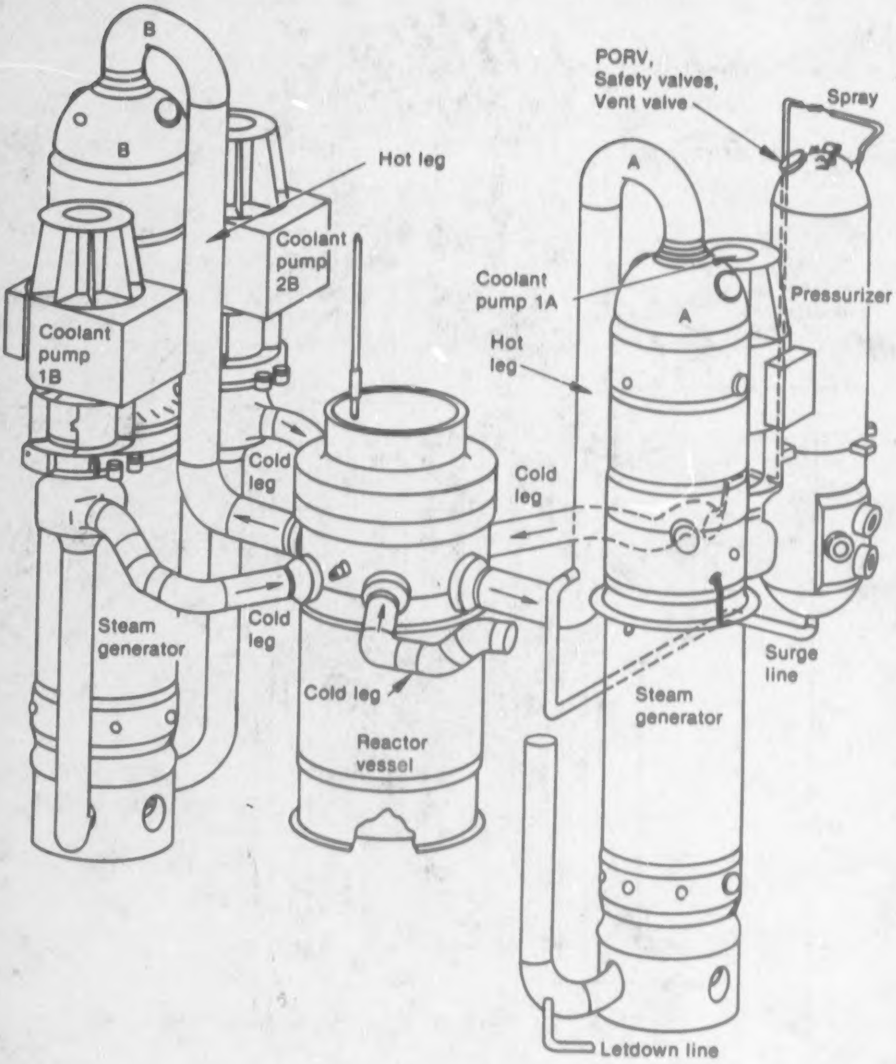
Removal of the reactor core support assembly is scheduled for early Fiscal Year 1987, following removal of the core material found in the original core region. The objective of this significant task is to achieve removal of core material which we feel may occupy sections of the reactor vessel outside of the original core region. The magnitude of this reactor component removal task has prompted us to schedule the commencement of core support assembly tooling activities in early Fiscal Year 1984. Tooling design and fabrication will continue through Fiscal Year 1985.

VI. CONCLUSION

The expected funding level for the overall TMI-2 Recovery Program is in accordance with Case 1 of the attached program estimate. As stated earlier, GPUNC is both in pursuit and planning to pursue activities to achieve core removal and disposal as expeditiously as resources allow. DOE's involvement at TMI-2 has contributed significantly. Hopefully, it will continue to contribute resources to support these efforts while at the same time, ensuring that some of the unique and very valuable information to be obtained from the accident is not forever lost.


POLAR CRANE
CRANE RAIL
SECONDARY SHIELD WALL
PRIMARY SHIELD WALL
MISSILE SHIELDS
PRIMARY SHIELD WALL
SECONDARY SHIELD WALL
STEAM GENERATOR
HEAD SERVICE STRUCTURE
WORK PLATFORM EL. 349'-0"
PRESSURIZER
347'-6"
347'-6"
POOL WATER EL. 346'-6"
RPV FLANGE EL. 322'-6"
REACTOR COOLANT PUMP
REACTOR VESSEL
STEAM GENERATOR
305'
305'
282'-6"
282'-6"

REACTOR BUILDING CROSS SECTION


B
B
Hot leg
Coolant pump 2B
Coolant pump 1B
PORV, Safety valves, Vent valve
Spray
A
Coolant pump 1A
Pressurizer
A
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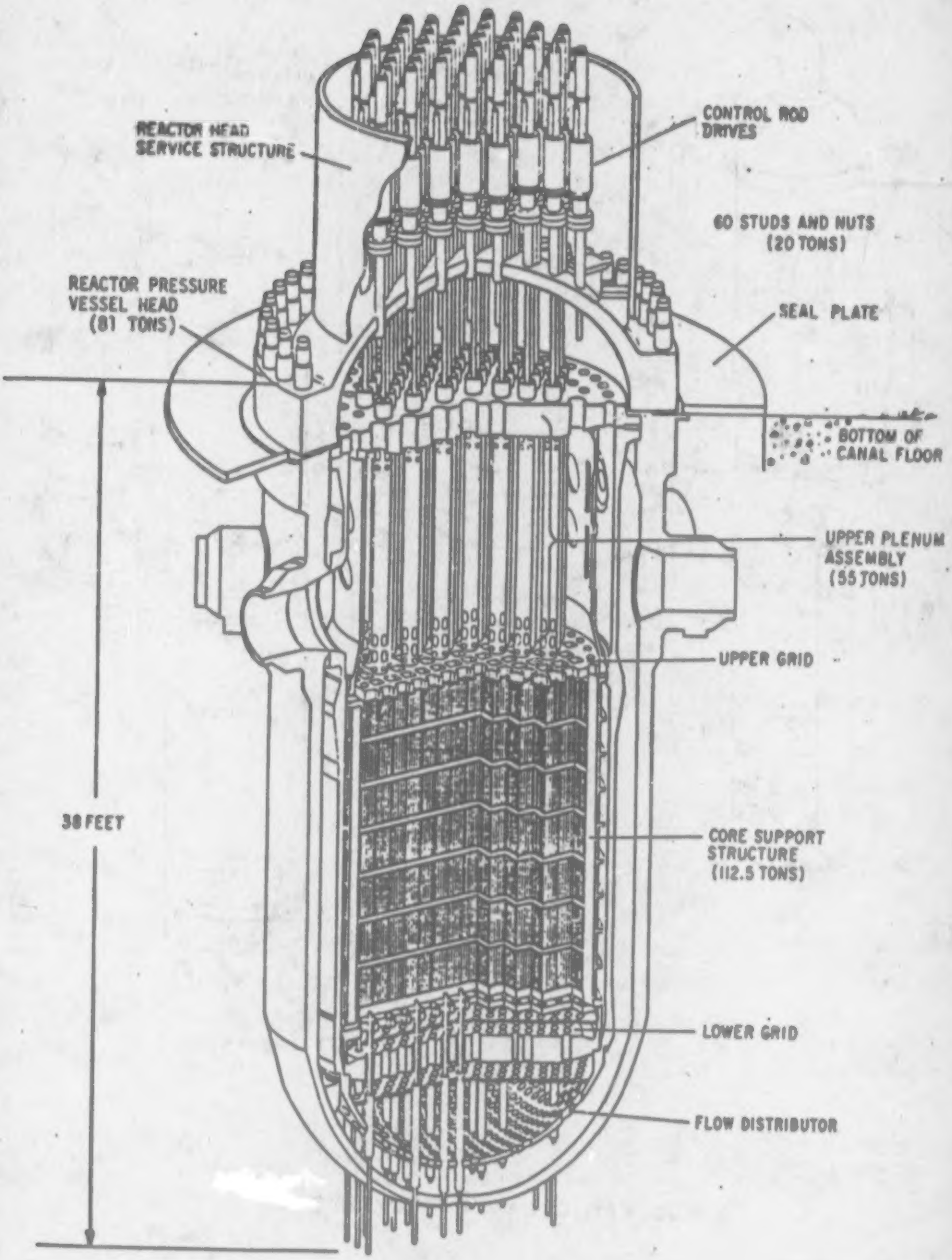
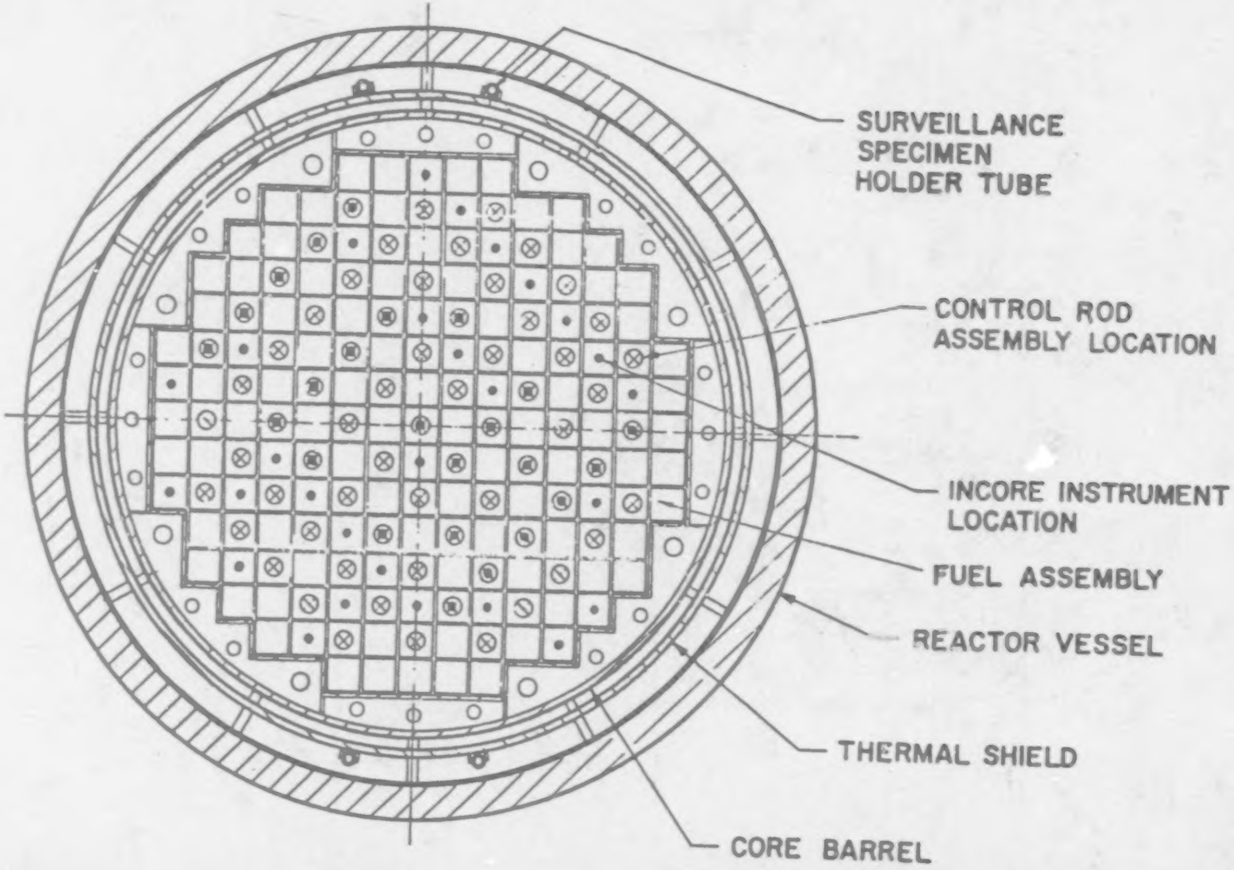
Cold leg
Steam generator
Cold leg
Reactor vessel
Surge line
Steam generator
Letdown line

NUCLEAR STEAM SUPPLY SYSTEM

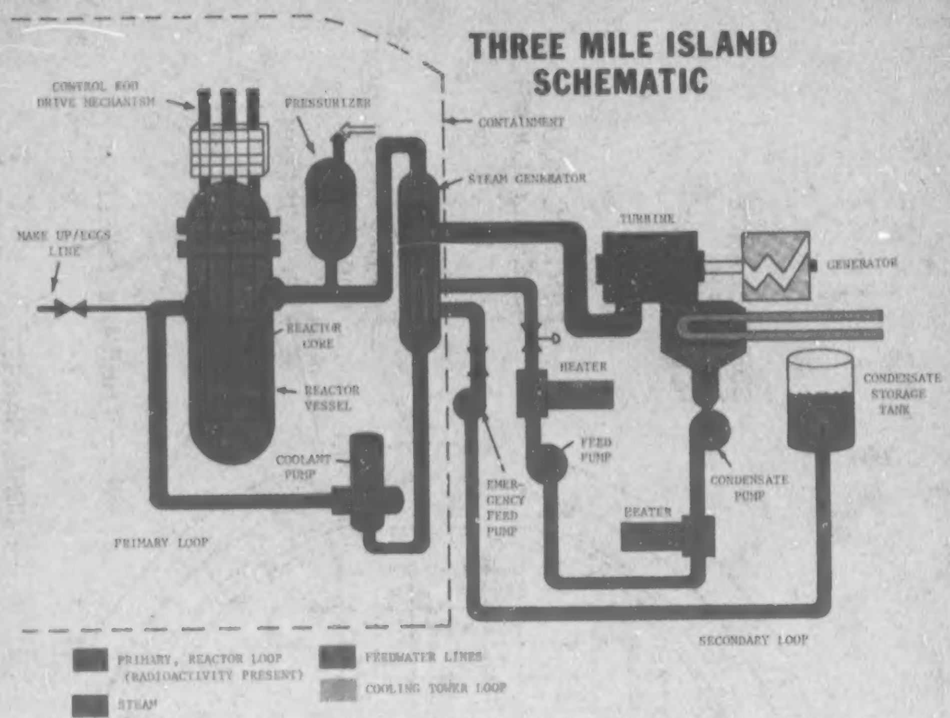

REACTOR HEAD SERVICE STRUCTURE
CONTROL ROD DRIVES
60 STUDS AND NUTS (20 TONS)
REACTOR PRESSURE VESSEL HEAD (81 TONS)
SEAL PLATE
BOTTOM OF CANAL FLOOR
UPPER PLENUM ASSEMBLY (55 TONS)
UPPER GRID
38 FEET
CORE SUPPORT STRUCTURE (112.5 TONS)
LOWER GRID
FLOW DISTRIBUTOR

REACTOR VESSEL CROSS SECTION

REACTOR CORE CROSS SECTION


SURVEILLANCE SPECIMEN HOLDER TUBE
CONTROL ROD ASSEMBLY LOCATION
INCORE INSTRUMENT LOCATION
FUEL ASSEMBLY
REACTOR VESSEL
THERMAL SHIELD
CORE BARREL

THREE MILE ISLAND SCHEMATIC


CONTROL ROD DRIVE MECHANISM
PRESSURIZER
CONTAINMENT
STEAM GENERATOR
MAKE UP/ECCS LINE
TURBINE
GENERATOR
REACTOR CORE
REACTOR VESSEL
HEATER
CONDENSATE STORAGE TANK
COOLANT PUMP
FEED PUMP
EMERGENCY FEED PUMP
CONDENSATE PUMP
HEATER
PRIMARY LOOP
SECONDARY LOOP
PRIMARY, REACTOR LOOP (RADIOACTIVITY PRESENT)
FEEDWATER LINES
STEAM
COOLING TOWER LOOP

SQUARE HALFTONES

Mr. **Hall.** Mr. Arnold, on page 2 of your testimony you mentioned that 30 EPICOR-II containers had been shipped to DOE. In your view, what R&D is needed on these EPICOR-II containers, Mr. Arnold?

Mr. **Arnold.** The R&D relative to the EPICOR-II containers really started with activities on the site. We generated those containers in the course of cleaning up the water. We were applying state-of-the-art technology, and one of the things that was necessary to assure safe shipment was to know that the containers would be intact for the period of time when the material would be stored and would subsequently remain safe in terms of gases generated within the containers.

Research was done to develop techniques for the examination and testing of the conditions of the containers, inerting them for shipment, and safely shipping them to the Idaho site. What is now needed, I think, is an ongoing surveillance and examination of those containers' conditions with time and the development of techniques for appropriate shallow-land burial of that material.

Mr. **Hall.** Would you, just for the record—and perhaps your written statement contains it—describe for the record the EPICOR-II resin containers?

Mr. **Arnold.** Yes. The containers of interest here are carbon steel drums, so to speak, that are 4 feet in diameter and 4 feet high. They have some fixtures on the top for processing water and the examination of the internals of the drums subsequently.

Mr. **Hall.** On page 3 of your testimony, you mentioned that there were no health effects to the public from venting of the krypton gas. Can you explain that?

Mr. **Arnold.** Yes. The krypton that was vented from the reactor building in the early summer of 1980 led to a total offsite exposure to the public of less than 1 man rem. Individual members of the public received, as I recall the number, considerably less than 1 millirem of exposure. It was done under very carefully controlled conditions and I think would, by all experts, be considered of no health consequences whatsoever.

Mr. **Hall.** You have indicated that the upper 5 feet of the fuel assemblies had been reduced to rubble. What is your feeling about the remaining footage, the remaining 11 feet of the fuel assemblies, as to whether or not they will crumble on any attempt to remove them or disturb them?

Mr. **Arnold.** I think we probably have a range of conditions of the fuel assemblies. In terms of those that are in the central portion of the core from a radial location standpoint, the upper ends of those have been, as was indicated, reduced to rubble, with the lower portions of them probably showing varying degrees of mechanical degradation. I think we will probably find that all the fuel assemblies, including the outermost ones, have been damaged in the sense that they have been exposed to temperatures in excess of those temperatures that would make them suitable for further service. They may still be geometrically intact. Our removal planning anticipates that we will not be able to handle them as normal fuel assemblies, though, because of a reduction in their strength characteristics, even though their geometry is intact. So, for all practical purposes, we consider the core to have been damaged beyond any use of any of the components, and the planning has to be based upon expectations that we must remove fuel pieces ranging from very small to relatively large sections of a fuel assembly.

Mr. HALL. On the reactor disassembly activity that you alluded to in your testimony, will that vessel be removed from the plant? Do you plan to reuse it? Can you reuse it? What are the facts with regard to that?

Mr. ARNOLD. The analysis that we have done to date indicates that the reactor vessel and the reactor vessel head would not have been made unusable by the accident. We would anticipate all the internal components of the reactor vessel are unusable. Our planning at this point is based upon a recovery of the facility, but whether that will be technically and economically feasible will have to await further progress on the cleanup, as will the true ability to determine whether the reactor vessel can be reused.

Mr. HALL. Would you enlarge on what you mean by "smearable levels".

Mr. ARNOLD. Yes. In the decontamination of the facility and the reactor building particularly, we are really striving to do two things. We are trying, first of all, to reduce the levels of radiation, that is what our people are exposed to by the emissions from the radioactive material. The second thing we are trying to do is to recapture and immobilize the radioactive material itself, and what we have seen with the decontamination is that this radioactive material, which we consider to be loose surface contamination—that is, it can be wiped around or smeared on surfaces because it is loose and not fixed to the surface—had been substantially reduced by the techniques that we have utilized for decontamination in the building.

Mr. HALL. You mentioned the overall program schedule for the cleanup effort and the problems that you are having there. The cleanup effort funding is limited. How much faster, if you were funded, could you effect this?

Mr. ARNOLD. In the attachment to my prepared statement, we have a copy of the recovery program estimate, and there are details in there. But let me just try to summarize them for you, if I may, Mr. Hall.

Mr. HALL. Tell us how much additional money would be needed, would you?

Mr. ARNOLD. What is interesting is that the money needed is a matter of timing and not amounts. We have estimated that from the beginning of 1983 onward, in 1983 dollars, my recollection is that it is about $500 million needed for efforts yet to go. What we need is on the order of $20 to $30 million in 1983 dollars in 1983, 1984, and 1985 to expedite as much as practical the cleanup program. That would lead to a 1-year earlier date on core removal, and it would lead to a total program improvement of about 2 years.

Mr. HALL. If you charged your customers for the additional money, about what would be their rate increase, either in dollars or percent?

Mr. ARNOLD. Perhaps I could ask to join me at the table right now Mr. John Graham. Some of these questions he might be better able to answer than I am. Mr. Graham is the vice president and treasurer of the General Public Utilities Corp., the parent company of GPU Nuclear and the parent company for the owners of Three Mile Island.

The program anticipates that we will have funding at the level of about $50 million per year from our customers. If we said that we would require an additional $25 million per year from them, I think that might be the relevant number to use for estimating an increase in rates.

Mr. **Graham**. There is some variation, depending on which of the three operating companies you are looking at. The $50 million per year that we now get is about 2 percent of our revenue. So another $25 million would be about another 1 percent. For the customers of Metropolitan Edison Co., it would be something more than that, perhaps on the order of twice that for the customers of Pennsylvania Electric Co. For Jersey Central Power & Light, it would be something less, perhaps half of that. But the magnitude is in the range of a few percent of our revenues.

Mr. **Hall**. I did not totally understand Mr. Arnold a moment ago when he said it was not the amount of money but the timing of it. You have delayed your cleanup schedule by about 2 years. If it is not the amount, why the delay? Just give us your position on the delay and what occasions that.

Mr. **Arnold**. Let me perhaps try to clarify the answer I gave earlier, which might have been stated quite awkwardly. The funding so far has been restricted to $60 or $65 million per year for 1981 and 1982. We are anticipating about $76 million in 1983. The program reassessment was based upon $100 million per year in 1983 dollars in 1984 and beyond. So we anticipate being able to increase the spending in 1984 from about $76 million to $100 million in 1983 dollars. As we look at a funding level that would be at $100 million per year in 1983 dollars and how that stretches out the job, that in itself increases the cost. If we had earlier in that program additional funding available, such that we could pursue it more rapidly, we actually end up with the cost being a few million dollars less in total because we do not have the effects of the fixed ongoing cost and the effects of inflation at the tail-end of the program, but it does require higher funding levels in the intervening years.

Mr. **Hall**. I think you know Mrs. Bouquard, who chairs this subcommittee, introduced legislation last year regarding the cleanup of Three Mile Island and any future nuclear powerplant accident sites that might occur. Are you familiar with this legislation?

Mr. **Arnold**. I am not in detail, Mr. Hall.

Mr. **Hall**. Would either Mr. Graham or Mr. Kanga care to comment on it?

Mr. **Arnold**. I regret that I do not think we are.

Mr. **Hall**. You may be able to provide an answer at a later time for the record.

Mr. **Arnold**. We would be really happy to do so.

Mr. **Hall**. Are there other questions from the gentleman from California?

Mr. **Lowery**. I will yield to my colleague from Pennsylvania.

Mr. **Hall**. Mr. Walker.

Mr. **Walker**. Thank you, Mr. Chairman.

The revised cost estimates that you provided for the committee here is the one that was announced late last year or early this year. If I recall, it is going to take a little longer period of time but ultimately is going to cost less dollars than originally estimated; is that a fair summary?

Mr. **Arnold**. Yes, somewhat less.

Mr. **Walker**. Since normally on projects that we consider around here, longer times mean more dollars, how is it that we ended up on this with a longer period of time coming out to less dollars?

Mr. **Arnold**. The major contributor to that, Mr. Walker, is a different understanding of what the technical requirements of the job would be and some encouraging results in the 1981 and 1982 efforts, in terms of what would be required. Second, I think I would have to identify that in the earlier estimates, we attempted to be sure that we were planning the job so that we could be as confident as reasonably achievable that the job could be done in the timeframe and with the dollars that we are identifying. So we were providing more in the way of contingency efforts for developments going differently than were anticipated.

This program estimate is based upon assumptions that do not include provision for as much in the way of effort for providing alternatives or contingencies for the plant not proceeding to be cleaned up in the way we expect to be able to progress the job.

Mr. **Walker**. How much of the money involved in the revised plan is aimed at doing things that would later allow you to recover the plant?

Mr. **Arnold**. Zero.

Mr. **Walker**. So, in other words, the revised cost estimates are based upon cleanup without anticipation of recovery, and any recovery costs for the plant would be add-on costs for some later period? Is that a fair statement?

Mr. **Arnold**. The latter part of it certainly is, that any recovery costs would be add-on. We have made, as a matter of policy or guidance for the people, that their cleanup effort should not be moved forward in ways that would constrain us from recovering the plant without there being a specific decision on that. But the planning and the work is going forward without making any investment in preservation of the facility for any effort toward eventual recovery. They are targeted only toward an expeditious cleanup.

Mr. **Walker**. To clarify it, if you are faced with two options, one which is cleanup and the other which is cleanup plus activities that may have some advantages of recovery but would cost more, then you are not choosing that second option simply because it would add to recovery later on?

Mr. **Arnold**. In all honesty, we have not come up against that situation yet. What we have said is, if we get to that situation, we want to be sure there is a management review of the decision, but my present expectation is that we would be electing the least-cost method.

Mr. **Walker**. I ask the question primarily because it has some effect on funding decisions that are made now and made in the future with regard to Federal money going in. I think the whole concept of whether or not Federal money is being provided as a partial bailout for GPU becomes far more antagonistic if in fact it appears as though the money is being spent for recovery. If we are spending the money toward pure cleanup costs, it becomes far more easily justified to authorize the research program. That is the reason for the question.

Are you satisfied at this point with what you are hearing about the industrywide cooperation on financing cleanup?

Mr. **Arnold**. Let me ask Mr. Graham to respond to that, if I may, because I am not close to that effort.

Mr. **Walker**. Fine.

Mr. **Graham**. As you may know, the industry in January met, the EEI board of directors, and committed to a $150 million program among all of the investor-owned utilities. That has two conditions in it. One is that $100 million be committed and the second is that we get a favorable ruling from the IRS that the contributions being made by those companies will in fact be tax deductible. I believe the application for the tax ruling either has just been filed or is about to be filed. We are now soliciting pledges. I do not know the exact amount that has been signed up. There is some feeling of confidence that we can get to the $100 million figure, although it is going to take some work on the part of the industry to get there. We hope that by the middle of this year or the third quarter of this year, we will be in a position to have that money start to flow.

Mr. **Walker**. Thank you. In essence, as I understand the situation at Three Mile Island, you still are in effect operating unit 2, the damaged reactor; is that correct?

Mr. **Arnold**. Yes, sir.

Mr. **Walker**. Are you experiencing any problems in operating that damaged reactor? I guess my real question is, as time goes on, are you seeing that the deterioration is causing you additional difficulties in operations?

Mr. **Arnold**. The major interests in the operations we are doing so far are the operation of systems which assure stability and assure that we are monitoring any pathways of potential releases from the site. We are not experiencing any difficulty in operating the systems necessary to do both of those at this time. But I would point out that one of the reasons that this is the case is because of the very extensive modifications we made to the plant so that we would have, in effect, safety systems designed and in place and functional to deal with the present plant condition, and we have been able to basically uncouple ourselves from the original plant design equipment which served those purposes and which we are not in a position to be able to operate today.

Mr. **Walker**. So, in essence, what you are operating right now is kind of a backup plan?

Mr. **Arnold**. To a great extent it is, yes, sir.

Mr. **Walker**. Last year, I got enacted a provision which says that the water that is contaminated as a result of the accident cannot be dumped into the river. Is that something that you can continue to live with?

Mr. **Arnold**. From a very direct sense and for the near term, I think the answer is clearly yes. I think I do have concerns about some of the indirect effects of that restriction and the need we have to find some forum in which the public has confidence that we can have an assessment of the health significance of that water and find a way to deal with it on the basis of its health significance, but that is not a pressing issue.

Mr. WALKER. I appreciated your answer with regard to the krypton gas. You will remember, I was at the island the day you released the gas, so I am glad to know there were no health effects.

Mr. ARNOLD. Yes, sir, and you look fine to me.

Mr. HALL. Was Mr. Walker's presence there the reason you released it in such small quantities?

Mr. WALKER. Had there been no Federal research dollars allocated for the project, where would it be? Maybe a corollary question to that is: If for some reason Federal research dollars were cut off, what damage would that do to the cleanup schedule and to the process of achieving it?

Mr. ARNOLD. I think it would have been much greater by far than the fraction of dollars that the DOE expenditures represent relative to total activities. We have to spend a fairly large fraction—it has been in the range of $28 to $40 million at various times—of the first increment of money toward the maintenance of plant stability, being sure that we understand what we have, providing for contingency; whereas, the DOE funds have gone directly for research activities, which have really advanced the cause of cleanup. They have really led to the reductions in the levels of risk.

It is not just the dollars that the DOE has brought to bear. It has also been the technology and the expertise that has been available through DOE. I think the EPICOR-II liners, all 50, would clearly be onsite, and we may well have considerable uncertainty as to what their safety would be in that case, absent having had the assistance of DOE, just as an example.

Mr. WALKER. That was a question early in the cleanup effort, that is, what waste the Federal Government was going to accept. There had been a general agreement that they were going to accept the core when the core was removed. What is your agreement at the present time with DOE about the amount of waste or the kinds of waste that they are accepting? They are obviously accepting the EPICOR waste. Just where does that agreement rest?

Mr. ARNOLD. I would identify the waste in four categories: the SDS or zeolite that we have talked about; the EPICOR-II, which we have talked about; the damaged fuel, and we currently have an agreement in principle with DOE for them to take all of the damaged fuel, although we will have to make payments to them under the contract yet to be completed; and the fourth are what are called other abnormal waste, those that are not suitable for disposal at shallow-land burial. I do not think we will have large amounts of that type of waste, in terms of the diversity of it, but I think there will be some of that which we will be looking to DOE to accept.

Mr. WALKER. Finally, Mr. Graham, I do not think I really understood the precise impact of your answer to the chairman with regard to the amount it was going to cost the average customers. In fact, GPU customers were asked to bring their total—you used a figure of $25 million, and that would be 2 percent of your overall revenues. You did not mean to imply from that, you would only raise a customer's bill by 2 percent, did you?

Mr. GRAHAM. I understood the question to be for the rest of the funding that we need. For the part of the plan that was proposed by Governor Thornburg that we do not yet have, what would the impact be on customers? I understood Mr. Arnold to say that this would be about $25 million per year. That was why I described the——

Mr. **Walker**. I am trying to get around to the question of what kind of a burden would you put on the GPU customers if the money did not come from the industry or the money did not come from Federal sources. What would end up being the impact on GPU customers?

Mr. **Graham**. I think that is the correct answer.

Mr. **Arnold**. Let me clarify it. The $25 million was an estimate of the additional increment above $100 million per year, which is the base case. So I think Mr. Hall asked, how much more in customer revenues, what it would mean to their rates if you collected sufficient additional money from them to do the expedited cleanup case.

Mr. **Walker**. Move the whole thing forward?

Mr. **Arnold**. Right. So if we looked at what we currently are anticipating under the Thornburg plan of about $50 million per year, and we looked at an escalated case of approximately $130 million per year on the average, you can sort of look at it in two pieces. From $50 to $100 million, that is an additional $50 million, and then another $25 or $30 million for the fully expedited case. I think that with each $25 million goes a 1- or 2- percent increment in customer rates.

Mr. **Graham**. Yes, and let me try to add this. We now are getting about $50 million per year from our customers. What that means is that about 2 percent of our total revenue is devoted to cleanup. In MetEd's case, about 4 percent of their revenues is devoted to cleanup. Suppose we were getting no help from anyone else and all we had was customer revenues and the remaining insurance, and if we were going to spend the $100 million per year, that would mean we would just about have to double what we get from our customers. I think that puts an outer bound on it. That means that for MetEd's customers, it would go from 4 percent of their bills to about 8 percent. In the case of Jersey Central, it would go from about 1½ percent of their bills to about 3 percent.

We do not think that is going to happen. We have been getting help from the State of Pennsylvania, from the industry, from DOE, and I think that is why I was using the smaller number.

Mr. **Walker**. The fact is that Pennsylvania Public Utility Commission has indicated that they did not approve the kinds of rates necessary for the customers to bear the full cost of the cleanup?

Mr. **Graham**. They took a fairly adamant position early in the problem that was very close to that. They also accepted settlement of the case that included Governor Thornburg's plan. Governor Thornburg was fairly careful on several occasions to indicate that the exact components of the program were not intended to have been carved in stone by him. We have not had to raise with them the question of whether we needed something more than the money we are now getting; they would give that.

The Jersey Commission has indicated that they are willing to be a part of a sharing plan. They have not indicated that if something more was necessary from their customers, they would draw a line in the sand. So I do not think I necessarily agree that as we get closer to getting the thing funded, and if we need some small further amount from our customers, the State commissions necessarily will say no.

Mr. WALKER. That helps clarify the situation. Thank you, sir.

Mr. HALL. An increase in the rate base is inevitable, is it not?

Mr. GRAHAM. Sadly, we all live in an inflationary economy. Right now, we are seeing that fuel prices have stabilized and come down, so the nonfuel components have gone up somewhat and offset that. We are seeing some stability in our rates, after a time when our rates had to go up very rapidly. Now we are getting a breather, and our customers are getting a breather.

Mr. HALL. Mr. Graham, thank you.

Mr. LOWERY. Mr. Chairman, I have a couple of questions. I noted that Mr. Walker has tremendous interest in the subject. I have four relatively brief questions.

First, what are the odds that TMI-2 will ever operate to produce power?

Mr. ARNOLD. Mr. Lowery, I think that is really a question that a meaningful answer cannot be given to. I think that first and foremost——

Mr. LOWERY: Is it doubtful at this point?

Mr. ARNOLD. Yes, I think you would have to identify a fair amount of uncertainty associated with it. I think the first criterion is whether or not TMI-1 operates again. I do not think there is any chance that TMI-2 will operate if TMI-1 is not permitted to operate. In terms of the technical issues, we do not at this time know of any reason that TMI-2 cannot be recovered as a nuclear facility. I think I would have to identify, though, that the longer the cleanup takes, then the greater is the uncertainty as to whether technical problems will develop because of the effects of corrosion and other things.

Mr. LOWERY. What are you estimating to be the total cost, on an annual basis?

Mr. ARNOLD. I think that expenses from the time of the accident until we have the plant radiologically similar to a normal operating plant, with all the damaged fuel shipped off the site, all the unusual waste shipped off the site, would be a little bit under $1 billion.

Mr. LOWERY. And percentagewise, the source of funding for that?

Mr. ARNOLD. About $300 million of that will be covered by insurance. We would anticipate that perhaps $250 million would come from customers. $150 million from EEI. About $45 million from the States of Pennsylvania and New Jersey who, under the Thornburg program, would also contribute. The Thornburg plan included about $190 million from the Federal Government. The present DOE program we would expect to contribute about $65 million in activities that offset what otherwise would have to be spent for cleanup efforts, although they are part of R&D.

I think those are the amounts that we can identify at this point.

Mr. LOWERY. The remainder would be from ratepayers?

Mr. ARNOLD. I think potentially from the ratepayers or, as was mentioned earlier, there has been an attempt to obtain overseas funding for the efforts here, and we will continue to try to keep the costs as low as we can.

Mr. Lowery. Is there an investor contribution?

Mr. Graham. Yes, there is. From the time of the accident until the beginning of the Thornburg plan, the beginning of 1982, the equity investors were paying all of the operating and maintenance expenses associated with the plant.

Mr. Lowery. How much was that?

Mr. Graham. That was about $40 million in that time period. In addition to that, the customers are not paying any of the capital costs associated with TMI-2, and there is an ongoing carrying cost associated with an investment of $800 million that is being borne by the investors.

Mr. Lowery. It is being operated as a damaged reactor. When do you expect total shutdown?

Mr. Arnold. I think within the parlance of the industry, we have been in total shutdown since about April 1979. We still, as would any plant that has operated and been shut down, must continue to maintain stability of core conditions—that is, keep water in the reactor vessel, and continue to monitor pressures and temperatures. But the reactor core is and has been shut down.

Mr. Lowery. Would you explain that a little further, because it is still operating.

Mr. Arnold. I think within our nomenclature we talk about operating a plant whenever there are systems that have to be operated. Perhaps an example would best illustrate it. The heating, ventilation, and air-conditioning systems of the plant are necessary for habitability, for control of any airborne radioactive materials, the cleanup of that.

Mr. Lowery. But as far as any reactions happening, that has not happened since last April?

Mr. Arnold. Really since the day of the accident itself, we were into a condition we considered shut down since about late April 1979.

Mr. Lowery. So, shutdown relates to your auxiliary system?

Mr. Arnold. Yes; the operation really refers to auxiliary systems.

Mr. Lowery. This is my first opportunity to chat with you folks about it. I know so much has been written about it and so much debriefing of the participants has taken place. In 20 words or less, what would you say happened; and in 20 words or less, who is responsible?

Mr. Arnold. I think first of all, it is clear that an accident of the nature of this one—we are going to be into some oversimplifications, but with that qualification, let me just try to very briefly describe it.

First of all, what happened at the time of the accident is that the operators of the plant were faced with a condition for which their training and procedures had not adequately prepared them. The plant responded in a way that was ambiguous relative to their procedures and training, and they did not recognize the conditions and their reaction to the conditions was inappropriate relative to what was physically happening with the plant and led to the core not being sufficiently cooled to the point that it severely overheated and was damaged as was described earlier.

I would think the Kemeney Commission summary of why it happened is probably as good a reference as any. It was the industry's accident. It was a result of problems in the utilities, the specific utility that was operating this plant, in terms of the preparation of its operators. But that was characteristic and our programs were characteristic of industry practices and industry insights at the time. We really were in a situation—and still are—where we have a maturing technology. It is absolutely essential that we recognize that in the way in which we operate these facilities and support these facilities.

I think that there are many of the participants in the nuclear industry that have to sign up for a share of the blame, so to speak. We are willing to sign up for ours.

Mr. LOWERY. Could you prepare a full written analysis of what happened, for the record, on the basis of the questions that I asked?

Mr. ARNOLD. We will certainly try to do that, and if our initial response is not sufficient, please let us know.

Mr. HALL. Thank you, Mr. Lowery.

Mr. Arnold, Mr. Kanga, and Mr. Graham, thank you very much.

Our final witness in our hearing today is Mr. Ray Mairson, from the Westinghouse Electric Corp., who will testify on the West Valley project. It is my understanding that Mr. Mairson has about a 10-minute presentation film.

You may summarize, as you like, or stay with your original text, but your original text will go into the record.

STATEMENT OF RAY C. MAIRSON, PRESIDENT, WEST VALLEY NUCLEAR SERVICES CO., INC., WESTINGHOUSE ELECTRIC CORP., ACCOMPANIED BY SAMUEL A. SCHEER, MANAGER, PROJECT CONTROL, WEST VALLEY NUCLEAR SERVICES CO., INC.

Mr. MAIRSON. Thank you, Mr. Chairman. My name is Ray Mairson. I am president and project manager of the West Valley Nuclear Services Co., which is a wholly owned subsidiary of Westinghouse Electric Corp. We were selected as the prime contractor to the Department of Energy for the West Valley demonstration project. With me today is Mr. Sam Scheer, who is our project control manager.

I plan to deliver 2 minutes of opening remarks and then, with your permission, highlight the major progress to date in a 10-minute videotape and then to proceed to any questions you may have.

Mr. HALL. Fine, Mr. Mairson.

Mr. MAIRSON. My opening remarks will address the Westinghouse incentive for being in the project, then the proposed 1984 budget, and finally the status of our public information program.

Westinghouse is the largest nuclear plant designer and manufacturer in this country and probably in the world. There are those who perceive that the major obstacle to having a viable nuclear option in the United States is that we in the United States have not yet demonstrated the proper and safe disposition of spent fuel and of high-level liquid waste resulting from the reprocessing of spent fuel.

Therefore, the Westinghouse interest in eliminating this obstacle at the earliest time is obvious. Moreover, we believe that we have the best experience base to do this job. We staffed this project with an initial cadre of technical people, with combined nuclear experience in excess of 400 years, which I believe represents a strong Westinghouse commitment to the success of the project.

The West Valley demonstration project offers the first opportunity to demonstrate the safe solidification of high-level waste into a solid form that is suitable for permanent disposition in a Federal repository. The project also includes the demonstration of the safe decontamination and decommissioning of such a facility. With these incentives, I believe it is in the project's best interest to do this job in the shortest possible time, to do it with the maximum use of existing technology, and to do it at the least possible cost.

The proposed fiscal year 1984 funding level of $36 million, in our opinion, meets the minimum requirements for maintaining our project baseline schedule. This year, we carried out the major planning and the baselining of the project. In fiscal year 1984, we will carry out the plans that we developed this year. Major emphasis will be placed on waste solidification design and development, decontamination, and decommissioning, and on low-level waste treatment.

To maintain our progress on this schedule, fiscal year 1985 becomes a very critical budget year for us. We currently estimate that we will require about $60 million in fiscal year 1985. During that year, major equipment deliveries will take place, installation of the equipment will take place, and checkouts for what we are calling the Component Test Stand will be completed. We will be underway on major decontamination activities in the facility, we will have a sludge mobilization system designed, and we will deliver the equipment necessary to process the supernatant in the waste tank.

In closing, I wish to report that the public information program which was put into place at the outset of the project has resulted in a positive public acceptance of the facts that the project provides first a solution to an existing environmental problem, that a competent team is in place, and that the public will continue to receive candid reports on the progress in the project. It is aggressive, it has been successful, and it will be continuing.

I will be pleased to answer questions either now or following the videotape, which takes precisely 10 minues.

[The prepared statement of Mr. Mairson follows:]

STATEMENT OF RAY C. MAIRSON, PRESIDENT, WEST VALLEY NUCLEAR SERVICES CO.

Madam Chairman, my name is Ray Mairson and I am President and Project Manager of the West Valley Nuclear Services Company, a wholly owned subsidiary of Westinghouse Elecrtic Corporation. We were selected as the prime contractor to the Department of Energy for the West Valley Demonstration Project. With me today is Mr. Sam Scheer, our Project Control Manager.

I plan to deliver 2 to 3 minutes of opening remarks, highlight major progress through a 10-minute videotape with your permission, and then proceed to any questions you may have.

My opening remarks will address the Westinghouse incentive for being in the Project, the proposed fiscal year 1984 budget, and the status of our public information program.

Westinghouse is the largest nuclear plant designer and manufacturer in this country and probably in the world. There are those who preceive that the major obstacle to having a viable nuclear option in the United States is that we in the United States have not yet demonstrated the proper and safe disposition of spent fuel and high level liquid waste from reprocessing of spent fuel.

Therefore, the Westinghouse interest in eliminating this obstacle at the earliest time is obvious. Moreover, we believe that we have the best experience base to do this job. We staffed this project with an initial cadre of technical management people with a combined nuclear experience in excess of 400 years, which represents a strong Westinghouse commitment to the success of the project.

The West Valley Demonstration Project offers the first opportunity to demonstrate the safe solidification of high level wastes into a solid form suitable for permanent disposition in a Federal repository. The project also includes demonstration of the safe decontamination and decommissioning of a facility such as this.

With these incentives, it is in the Project's best interest to do this job in the shortest time possible, with the maximum use of applicable existing technology, and at the least possible cost.

The proposed fiscal year 1984 funding level of $36M, in our opinion meets the minimum requirements for maintaining the project schedule. Having completed the major planning, characterization, and baselining this year, the fiscal year 1984 activities will be the implementation of these plans. Major emphasis will be in waste solidification design and development, decontamination and decommissioning, and low level waste treatment.

To maintain our progress on the aggressive project schedule, fiscal year 1985 becomes a very critical budget year—we currently estimate that about $60M will be required. At this time major equipment deliveries, installations, and checkouts for the Component Test Stand will be completed, major decontamination activities will be underway, the sludge mobilization system will be designed, and supernatant processing equipment will be delivered.

In closing, I wish to report that the public information program which was put in place at the outset has resulted in positive public acceptance of the facts that the project provides a solution to an existing environmental problem, a competent team is in place, and the public will continue to receive candid reports on progress.

I shall be pleased to try to answer your questions either now, or following the showing of the videotape.

BIOGRAPHY, RAYMOND CHARLES MAIRSON

Mr. Ray C. Mairson was appointed President and Project Manager for the West Valley Nuclear Services Company, a wholly owned subsidiary of Westinghouse Electric Corporation, in August 1981. In this capacity he is responsible for the performance of the work specified by the West Valley Demonstration Project Act, Public Law 96-368, as the prime contractor to the Department of Energy.

Mr. Mairson received a B.S. degree in electrical engineering from the University of California in 1949, and began employment as an engineer with Westinghouse immediately following graduation. He spent the next 22 years in various assignments at the Bettis Atomic Power Laboratory where Navy nuclear ship power plants are designed, built, and operated. Mr. Mairson was manager of the Idaho Naval Reactor Facility from 1965 to 1968.

Mr. Mairson's next assignment was outside of nuclear power in Westinghouse transportation systems. He was the general manager of the Brazilian subsidiary which provided the signalling, telecommunications, and traction systems for the Sao Paulo Metro, the first major rapid transit system in South America.

Mr. Mairson then returned to the nuclear power field as the construction manager of the Fast Flux Test Facility in Hanford, Washington, from 1974 to 1978. From 1978 to 1980 he was the project manager for the Waste Isolation Pilot Plant in Albuquerque, New Mexico. From 1980 to 1981, Mr. Mairson was director for all Westinghouse nuclear waste isolation programs.

Born in Chicago, Illinois, Mr. Mairson currently resides in Colden, New York with his wife Marianne.

Mr. HALL. Why don't we have the tape.

Mr. LUNDINE. Mr. Chairman.

Mr. HALL. Yes, Mr. Lundine.

Mr. LUNDINE. Excuse my interruption. Due to an absolute and unbreakable commitment, I have to leave. However, I hope that the Chair will give the witness the opportunity to answer what I understand has been a charge that a very small amount of money which has been allocated to West Valley is actually going into worthwhile project activities, and that most of the money allocated for this project has been used just for maintenance there during the requested period.

Mr. **Hall**. Surely, we will give him that opportunity. Because of my knowledge of your particular interest in this project, we will give him the right to answer that now.

Or would you prefer to submit a written answer for the record, Mr. Mairson. However you and Mr. Lundine would want to handle that is agreeable to the Chair.

Mr. **Mairson**. I can respond orally at this time. If he wishes a written response, I can do that as well.

Mr. Lundine, I am not familiar with that charge. However, I can tell you what the numbers are. Our fiscal year 1982 budget was approximately $10 million. To provide a basis for comparison, during the time that Nuclear Fuel Services was operating the plant in a shutdown condition over the years, they had approximately 47 to 50 people in residence there just to keep the plant in that condition. Their costs were averaging about $5 million per year.

If I were to use that number, I would say that less than $5 million of the $10 million was to do that sort of function. Actually, I think we gained much more than that from the $10 million. We did a great deal of our initial moving, assembling of the team, providing facilities and office space, for accommodating those people. You realize that in fiscal year 1982, we did not receive possession of the site until February 25, 1982. So we have just been in possession of the site for barely over a year. Prior to takeöver, none of the expenses of the site were ours. The video tape will show what we have accomplished in the past year since we took over the site.

In fiscal year 1984, we are anticipating a $36 million budget. Of that amount approximately $7 million would be assigned to do the routine maintenance, pay for the utilities, and do all of those things which are required to operate and maintain a site like that. The total remaining dollars, $29 million, are for making rapid and significant progress on the project itself.

Mr. **Lundine**. Thank you very much. And thank you, Mr. Chairman, for your courtesy. While the project is no longer in my district, due to the effects of reapportionment, I am intensely interested. I must say, I think they are making excellent progress, and I would substantiate what Mr. Mairson has said with regard to the public information program.

Mr. **Hall**. Thank you, Mr. Lundine.

I would suggest that inasmuch as you will have the recording that you go ahead and show the film basically for the benefit of the staff. Because I also need to leave and because you have been very courteous and waited your time, I think you and the subcommittee will get as much benefit from your testimony by having it in the record.

For the record, I might say that our next hearing on the budget for the Department of Energy for fiscal year 1984 will be tomorrow, beginning at 2 p.m. in this room. We will be receiving testimony from DOE and nongovernment witnesses on the uranium enrichment program.

We will have questions for you for the record and do thank you and Mr. Scheer for sitting here all morning, waiting. Believe me, the effect of your testimony is as great as those who testified first because it will be in the record and that is basically what we have gone through. We sure do thank you for your courtesy.

Mr. **Mairson**. If I could make one additional remark, Mr. Chairman, I was listening to you talk earlier about your concern in the public information field, getting messages to people.

Mr. **Hall**. You alluded to that, and I appreciated it in your presentation.

Mr. **Mairson**. We have found that if one can reach high school and junior high school students, which we did, you find that once they have received straightforward factual information, they are very receptive.

Mr. **Hall**. I found the same thing.

Thank you, Mr. Mairson. You may proceed with the film. This presentation will be a part of the record, and the subcommittee will be adjourned after accepting the film.

[The video tape was shown.]

Mr. **Ventre**. Thank you, Mr. Mairson. Pursuant to the order of the Chair, the subcommittee is adjourned.

[Whereupon, at 12:45 p.m., the subcommittee adjourned, to reconvene at 2 p.m., Thursday, March 10, 1983.]

APPENDIX

WZ:83:0033

West Valley
Nuclear Services Company
Incorporated

P.O. Box 191
West Valley, New York 14171-0191

April 20, 1983

Honorable Marilyn Lloyd Bouquard
Chairman, Subcommittee on Energy
Research and Production
Committee on Science and Technology
Suite 2321 Rayburn House Office Building
Washington, D. C. 20515

Dear Madam Chairman:

Thank you for the March 9, 1983 opportunity to testify before your subcommittee on DOE's West Valley Program for Fiscal Year 1984. I feel the Project has made excellent progress to date, and anticipate continued success through scheduled completion.

Your letter of March 25, 1983 requested my response to additional questions on or before April 30, 1983. Attached are my responses.

If I can be of any further assistance, please feel free to contact me.

Very truly yours,

RC Mairson

R. C. Mairson
President

AA:83:0045

SAS:mjd

Attachment

cc: J. A. Turi (DOE-HQ)
W. H. Hannum (DOE-WVPO)

QUESTIONS AND ANSWERS
RAY C. MAIRSON, PRESIDENT
WEST VALLEY NUCLEAR SERVICES COMPANY
SUBCOMMITTEE ON ENERGY RESEARCH AND PRODUCTION
SUPPLEMENT TO MARCH 9, 1983 TESTIMONY

O WHAT WORK IS INCLUDED IN THE REMODELING OF OFFICES?

The West Valley Site administrative office facilities are being remodelled and expanded as necessary to house DOE, New York State and West Valley Nuclear Services Company Engineering, Purchasing and Project Control personnel necessary for the accomplishment of the project.

The expansion was accomplished with the use of DOE furnished mobile office trailers relocated from Butte, MT; Grand Junction, CO; and Argonne National Labs in Chicago Ill. The trailers were remodeled to accommodate the West Valley personnel, using existing partitions, panelling, heating, air conditioning, lighting and utilities as part of the modifications.

For the existing plant and administration office facilities, WVNS repainted the walls, repaired damaged floor tile and enlarged the plant lunch room to accommodate the increase in personnel.

O WHAT IS THE NUMBER OF MANAGERS, ENGINEERS, TECHNICIANS AND ADMINISTRATIVE SUPPORT PERSONNEL ON SITE NOW, AND WHAT LEVEL IS THIS WORK FORCE EXPECTED TO REACH?

Of 174 Westinghouse personnel currently on site, 41 are managers and supervisors, 35 are engineers, 65 technicians/crafts, and 33 administrative support.

The peak in site personnel is currently projected for FY 1988 - the year solidification of the high level waste will begin. Of 275 site personnel anticipated, most of the increase will be engineers and technicians. This compares with Nuclear Fuel Services Company staffing levels during reprocessing operations of 196; including 41 managers and supervisors, 21 engineers, 112 technicians/crafts, and 22 administrative support.

0 DOES THE NRC EXPECT TO HAVE A REPRESENTATIVE STATIONED AT WEST VALLEY?

No. The Project is operated as a DOE facility, the regulations which apply, -- including those related to public safety--are DOE regulations and directives. DOE consults regularly with the NRC and seeks their review of matters which could affect public safety. As part of that consultative role, DOE arranges for NRC to conduct a variety of monitoring visits. WVNS, as the Operating Contractor, naturally cooperates openly and willingly with the NRC, as directed by DOE. But NRC does not now have, and I'm unaware of any consideration of NRC having, a representative stationed at West Valley.

0 WHAT ANALYSIS HAVE BEEN PERFORMED TO DETERMINE THE APPROPRIATNESS OF DESIGNING AND FABRICATING SOLIDIFICATION EQUIPMENT FOR LATER USE AFTER IT HAS SATISFIED THE NEEDS OF SOLIDIFYING WEST VALLEY WASTE (IN OTHER WORDS, DISMANTLING THE EQUIPMENT AND TRANSPORTING IT TO ANOTHER SITE)?

A design requirement for the WVDP solidification process is the capability for easy assembly and remote disassembly. The process system will consist of modular units that would facilitate remote replacement, packaging and transportation. This design feature should enable the components to be available for use at another site. It is not expected that solidification equipment will be used for more than one or two years for process adaptation, and a few years production operation. Efforts would involve decontamination of the equipment and appropriate packaging and transportation, but the subsequent use of the West Valley solidification equipment may be feasible. However, the equipment is not being designed specially for lifetimes beyond this project.

0 WHAT PREVIOUS DESIGN EXPERIENCE IN GLASSIFICATION, AND IN THE NUCLEAR AREA, IN GENERAL, DOES VITRO ENGINEERING HAVE?

Vitro Engineering, under contract with Battelle Laboratories, provided engineering effort on the first vitrification project to utilize actual, not simulated waste. This Nuclear Waste Vitrification Project was completed in 1978.

Vitro has been involved with the West Valley Plant since early 1980. At that time, Pacific Northwest Laboratories (PNL) asked Vitro to do a preconceptual design of the reference Borosilicate Solidification Process. Vitro technical personnel, in the course of accomplishing this program, made several trips to become acquainted with the plant. After completing this design work, Vitro furnished a cost estimate as required and handled several other West Valley related jobs for PNL. The work done for PNL by Vitro was under a DOE/RL contract.

In addition, Vitro teamed with their sister company, Nuclear Energy Services (NES) to provide technical assistance to the New York State Energy Research and Development Authority (NYSERDA) in 1981. The two contracts from NYSERDA were for a physical plant structural evaluation and an operability study. Both contracts required Vitro to become familiar with the plant facilities and operation.

This experience has proven very useful in providing engineering support services to help WVNS readily and efficiently explore various conceptual design approaches. Because of their role in the conceptual design, Vitro is not eligible to become the project Architect Engineer.

0 WHAT MAJOR DECONTAMINATION TASKS LIE AHEAD?

The decontamination is a two fold effort: that which must be done to permit modification and use of the existing facilities for solidification, and that which must be done to decontaminate the facilities after their use for solidification.

The existing facilities which are currently identified for use in solidification consist of shielded cells and laboratories which were used in processing of spent reactor fuel. The cells comprise approximately 70 percent of the shielded volume in the plant. They include the three major cells and several smaller cells. The purpose of the decon effort is to reduce the radiation and contamination levels in the cells to permit manned entry for removal of fuel processing equipment and modification and installation of project equipment. This will be a substantial effort, requiring several years to complete.

0 WHAT CONTRIBUTION ARE THE SAVANNAH RIVER AND IDAHO NUCLEAR ENGINEERING LABORATORIES MAKING TO SLUDGE REMOVAL SINCE THEY HAVE BOTH HAD EXPERIENCE IN DEVELOPING SIMILAR TOOLING?

Idaho National Engineering Laboratory (INEL) has no experience in developing equipment for sludge removal because the waste at INEL is acidic and thus there is no sludge.

At both Savannah River and Hanford, however, a substantial amount of information is available relating to experience in removal of sludge from tanks. The Hanford Site has successfully applied sluicing for the large-scale removal of radioactive sludges from underground storage tanks. Since the late 1940's, more than fifty tanks, involving millions of gallons of sludge, have been sluiced and the solids processed for Uranium or fission product recovery. Savannah River also has extensive operating experience in sludge mobilization both at full-scale and reduced-scale. They have tested and demonstrated two sluicing systems for mobilizing sludge in-situ.

The WVDP is utilizing both Hanford and Savannah River experience to develop a suitable sludge removal system for West Valley. We have already incorporated the Savannah River approach of reduced-scale testing for determining a method for removing the sludge at West Valley. The Savannah River experience and equipment design information provide an advanced starting point for conceptual designs which are proceeding at West Valley. Savannah River has developed a system that has proven to operate under similar conditions and processing requirements as West Valley and this valuable guidance is not being overlooked.

Like Savannah River, Hanford is another important source of information. The Hanford type system can be used for water additions and is effective for washing down heavy sludge accumulations and attacking localized solid encrustations. Thus the Hanford experience is also being utilized.

O HOW MUCH DOES IT COST PER YEAR JUST TO OPERATE THE SITE WITHOUT CONSIDERING THE COSTS OF THE DEMONSTRATION PROGRAM?

It takes approximately $7 million to operate the site in a safe shutdown condition - excluding costs of the demonstration program. Typical activities include the labor and materials for routine maintenance, security, environmental and safety systems, environmental, radiological and safety monitoring, and the cost of utilities.

O DO YOU REALLY BELIEVE THAT THERE IS AN "AGGRESSIVE PROJECT SCHEDULE" FOR THE PROJECT, AS STATED ON PAGE 2 OF YOUR TESTIMONY?

Yes. At the outset of the Project, West Valley personnel met with DOE, other DOE subcontractors with expertise in all phases of nuclear waste activities, and with NYSERDA, and developed a project schedule that all agreed consisted of the minimal durations for decontamination, supernatant processing, sludge removal and solidification. The resultant Project schedule targeted start of both supernatant processing and vitrification in FY 1990.

WVNS and DOE personnel have continually been exploring ways, safe, aggressive and some non traditional, to further accelerate the completion of the Project. Several strategies were developed including a Component Test Stand which will have the capability to be directly converted into the High Level Waste Solidification Cell, the early processing of the supernatant and use of the latest decontamination techniques.

These key strategies together with the maximum application of existing process technology has been incorporated and resequenced in a new Project schedule. Start of supernatant processing and vitrification are now currently scheduled for FY 1987 and 1988 respectively.

O WHAT IS THE SCOPE OF WORK CONTAINED IN THE (A/E) BID PACKAGE AND WHY WILL IT TAKE UNTIL THE END OF FY 1983 TO AWARD AN (A/E) CONTRACT?

The announcement published in the February 24, 1983 issue of the Commerce Business Daily (CBD) contains the A/E scope of work. The CBD announcement, in effect, replaces the bid package. The scope of work may include feasibility and trade-off studies; conceptual, Title I and Title II design services; cost estimating and scheduling, Title III inspection of construction; and Title IV procurement. These activities may apply to the high level waste immobilization facility, the low level waste treatment facility, and a number of supporting systems.

The Architect Engineer selection process is proceeding in accordance with established Federal and DOE procurement regulations.

The present ambitious selection schedule anticipates a target placement date of July 12, 1983. As a result of budgeting changes, WVNS effected certain changes in the work program to permit concentrated efforts be applied toward the revised target date of July 12, 1983.

O WHY WILL IT TAKE UNTIL THE END OF FY 1983 TO COMPLETE A WASTE MANAGEMENT PLAN TO PROVIDE FOR WASTES GENERATED DURING THE COURSE OF THE PROGRAM?

An interim waste management plan was formulated in FY 1982 and is currently in effect at West Valley. This plan reflects the management of waste being generated as a result of continued site operations. It was considered preferable to have information from exploratory decon, and to have several key Project decisions, such as the waste solidification process agreed to before substantial detailed planning was undertaken. An updated plan for managing project waste generated in the solidification program is currently being developed, and we expect to begin discussion of this with the applicable agencies, i.e., U.S. DOE and U.S. NRC within the next several months. Approval would not be expected earlier than the end of FY 1983.

O WHAT IS SLUDGE CHARACTERIZATION EQUIPMENT AS MENTIONED IN THE 1983 ANNUAL REPORT?

Two mechanical devices were designed and fabricated and were used October 21 and 22, 1982 for waste tank characterization. A buoyancy probe device consisted of a stainless steel weight whose apparent weight was measured by a load cell. This was used to measure the specific gravity throughout the supernatant (it was found to be homogeneous) and define the sludge interface.

A shear-vane device, similar to those used in the area of soil mechanics was then used. This device consisted of a four-bladed vane attached to a vertical shaft driven by a gear motor. When this device was slowly rotated at various depths in the sludge, the reaction torque was measured by a load cell. This measurement could then be connected to quantitative shear stress values.

O HOW MUCH IS THE PREPARATION OF THE VEHICLE MAINTENANCE PROGRAM GOING TO COST?

The 1983 cost of maintaining the vehicle fleet is expected to be $4,200; $1,300 for preventative maintenance and $2,900 for necessary repairs.

The WVNS motor pool consists of 14 vehicles, including 9 trucks, a van fully equipped for response to environmental and personnel emergencies, one 4 x 4 security vehicle, and three station wagons. Eleven of the vehicles can be used on public roadways, but three are contaminated and available only for on-site use. Seven of the vehicles were assumed from the former operator, Nuclear Fuel Services, upon takeover and became the property of DOE. These vehicles have an average age of over 11 years. The remaining seven vehicles have been provided to the project by GSA. DOE vehicles are maintained on-site through the WVDP maintenance shop; GSA vehicles are maintained by outside commercial repair shops through a cooperative GSA agreement.

O WHAT IS A "BUDGET QUALITY COST AND SCHEDULE ESTIMATE" AS MENTIONED IN THE 1983 ANNUAL REPORT?

A "budget quality cost and schedule estimate" describes detailed cost and schedule baselines of sufficient accuracy, detail and quality to withstand the scrutiny of the Office of Management and Budget and Congress.

Q WHAT HAVE YOU DONE IN REGARD TO THE "PUBLIC INFORMATION PROGRAM" MENTIONED ON PAGE 2 OF YOUR TESTIMONY?

The importance of a public information program for the West Valley Demonstration Project was recognized at the outset by DOE and by Westinghouse. Despite the fact that the project provides a solution to an existing environmental problem by solidifying the high level radioactive waste and transporting it to a federal repository, much local public reaction was initially characterized by fear and suspicion. The former reprocessing facility operator had a policy of discouraging media coverage of on-site activities. Public concern was heightened by this air of secrecy. In contrast, the Project from its inception has had a full time, staff level public information management function, and a policy of openness with the media.

On the morning of the site takeover, several dozen radio, television and newspaper reporters were briefed on the project and toured through the plant. The new public information policies had an effect which was apparent in improved coverage of the project.

The WVNS policy of providing the media with ready access to project management, and reasonable access to the site, builds trust in the project management team with news editors. While project opponents' negative charges about the project are still sometimes reported, the charges are rarely aired until the reporter checks the facts with the project public information manager. Maintaining the trust of the regional media through the prompt and accurate reporting of both accomplishments and problems, as well as providing frequent opportunities for reporters to observe project operations first hand is vital. Without a doubt, effective use of the local and regional media is an effective method of disseminating information about the project to the regional western New York audience.

In addition, a key feature of the public information program is that it first identifies the various public audiences and their information needs, and then designs programs to meet those needs. In the local communities near the project, educators, churchmen, town administrators, as well as leaders from civic and business groups and Indian tribal leaders were identified and contacted. The DOE project director, the WVNS project manager and the public information manager met with each leader, explained the purpose of the project, and explained that the public information manager is available to contact at any time for more information.

By continually reinforcing these community leader contacts with additional information, a link from the project to the community via its leaders was forged. These contacts have served to reduce the spread of rumors about the project. For example, the local electric utility was working on the substation which serves both the project and the nearby town. When service was interrupted, the town mayor received telephone calls about an accident at West Valley. With one phone call to the public information manager, the mayor quickly determined that repair work was underway at the West Valley Substation and that the electrical outage was unrelated to the West Valley project. During the outage, the project used steam boilers for backup power. The editors column of the local paper explained that this was the reason for the water vapor plume visible in town.

The community leader contact program is interactive, in that community input is used to help shape the public information program. For example, when asked how to best convey project information to various groups, the answer almost always given by community leaders was to communicate directly. That is, have a project representative meet with various groups, discuss the project and answer the group's specific questions. This approach contrasts with using a local community participation and oversight group, which would report the results of project briefings to the community. Such an oversight group had originally been envisioned as part of the public information program. Based on the local community preference for direct information rather than information via a third party, federal funding for an oversight group was dropped.

Because there are so many local community groups, the direct information method requires that a large number of presentations be made. In the first year, hundreds of presentations on the West Valley Demonstration Project were made to groups like town councils, mayors, state and federal legislators, service clubs, hospital associations, field and stream clubs, church groups. firemen, policemen, civil defense and health departments, women's groups, Indian tribes, historical societies, youth groups and many others. Meeting local information needs directly obviously requires that a speakers bureau be formed and trained. The speakers bureau multiplies the number of direct community contacts that can be made, thus enhancing public awareness about the project. Speakers bureau participation also enhances employe interest in the community, in the project and in public issues.

Speakers bureau participants meet weekly and discuss project accomplishments and methods to present them. Members research topics and make presentations to the group on issues which are likely to come up as questions. Practice, preparedness, message strategy, and peer critique are emphasized.

Local school audiences are sought after. Superintendents, faculty associations, parent-teacher groups, vocational programs, area college groups, gifted learning classes and science classes have all heard presentations on the West Valley project. Comments from a group of eighth graders, who toured the facility after intensive instruction on energy, radiation, and nuclear power indicate why school students and teachers are an important audience.

Without a doubt, the single most successful public information program during the first year was a facility tour open to the public, which was held last J ne. The open house was announced in the local and regional newspapers and by a fact sheet mailing. Over 600 people attended, including representatives from all 3 Buffalo TV stations, both Buffalo newspapers and a number of regional papers.

The public information program seeks to meet the information needs of all groups in the community, including groups opposed to the project. In fact, establishing a channel of communication with project opponents is a necessity. The rationale behind project decisions is carefully explained to opposition groups, whose members are generally well informed about project issues. Special opportunities to discuss various issues with the facilities manager, the radiological health and safety manager, and the project director have been provided.

Opposition group assertions which involve radiation concerns are carefully investigated. When one opposition group claimed that radioactive materials had been illegally dumped into a creek, a team of project radiation technicians worked all night, carefully sampling area soil, water and vegetation to document that no dumping had taken place. The results of the survey were reported on television and in the newspaper the following day. Incorrect allegations and charges are discredited using media contacts.

While the magnitude of the task of providing information to the public at times seems overwhelming, the need to provide balanced and accurate information so that citizens can make informed judgments concerning this country's energy future is clear. Understanding public concerns and providing information to address these perceptions will enhance public confidence that the West Valley solidification and decontamination project will successfully demonstrate the management of high level wastes.

Q DO YOU FORESEE ANY SIGNIFICANT DIFFICULTIES IN THE OPERATION OF THE FACILITIES AT WEST VALLEY IN THE COMING YEARS?

No significant difficulties are foreseen in the operation of the facilities.

Normal start up problems are expected with new vitrification process equipment, tank sluicing model, and low-level waste solidification equipment. Occasional breakdowns and maintenance problems with 20-year-old plant equipment are also expected.

Department of Energy
Washington, D.C. 20585

May 12, 1983

Honorable Marilyn Lloyd
Chairman
Subcommittee on Energy Research
and Production
Committee on Science and Technology
Washington, D.C. 20515

Dear Ms. Lloyd:

On March 9, 1983, Assistant Secretary Shelby T. Brewer appeared before the Science and Technology Subcommittee on Energy Research and Production to discuss the nuclear programs authorization, particularly relating to converter reactor systems.

Following that hearing, you submitted written questions for responses to supplement the record. Enclosed are the answers to those questions.

If you have any questions, please call Diana Diamond or Tom Pretorius of my staff on 252-4277. They will be happy to assist you.

Sincerely,

Thomas H. Pretorius
for Robert G. Rabben
Assistant General Counsel
for Legislation

Enclosure

Question: Please explain how the Department intends to fulfill its responsibility under the Nuclear Safety RD&D Act of 1980.

Answer: The Department is fulfilling its responsibility under the Nuclear Safety RD&D Act of 1980 by addressing the three major requests made in the Act. These were:

(1) To establish a coordinated RD&D program in LWR safety
(2) To study the need for a reactor engineering simulator facility
(3) To assess the desirability of creating a Federal Corps for training reactor operators

In the first of its mandatory yearly status reports to Congress, responses to the second and third requests were supplied. For those two items, the Department recommended that neither a national reactor simulator facility nor a Federal Operations Corp be put in place.

With respect to the first item, the Department has not initiated any new safety technology R&D programs. Rather, it is acting in a capacity to coordinate a national Light Water Reactor Safety program among NRC, the Electric Power Research Institute, DOE, and the nuclear supply and construction industry. To accomplish this, the Department of Energy with the assistance of the above organizations will:

(1) define an integrated and comprehensive R&D program
(2) assist in the development of an acceptable framework to define and manage required safety R&D
(3) identify performer, schedule, and costs for required R&D efforts

Question: Please explain how and when the Department will act on the recommendations of the several working groups that were set up to implement the 1980 Act.

Answer: The Department has already acted on the recommendations of the several working groups in the sense that the recommendations of the working groups were used as input by the Department in preparing the overall recommendations for future R&D as described in the Management Plan submitted to Congress on March 31, 1983. With respect to conducting any actual R&D, the Department has concluded as a first step that the new R&D recommended would not require new funding but could be accommodated through adjustments in existing programs at NRC and within the industry.

The Department of Energy with the assistance of the working groups, NRC, Electric Power Research Institute, Institute for Nuclear Power Operations, electric utilities, and nuclear supply and construction industry is developing a coordinated comprehensive program by August 15, 1983, that will fold in these recommendations into current programs of these organizations.

Question: Please explain why the LOFT facility should be funded within the DOE budget when the Nuclear Regulatory Commission elected to terminate operation of the facility.

Answer: The Nuclear Regulatory Commission has determined that it is not in their best interest to continue full support of the R&D activities at the Loss-of-Fluid-Test (LOFT). DOE was instrumental in obtaining agreements and funding from NRC international organizations and the Electric Power Research Institute, to continue LOFT R&D to the satisfaction of all parties. (See also next Q&A)

Question: Please comment on the fact that the NRC's Advisory Committee on Reactor Safeguards recommended that the NRC terminate funding for LOFT in the content of the DOE funding request to support this facility.

Answer: The LOFT experimental program has until recently been sponsored by the NRC to provide information regarding regulatory concerns regarding the effectiveness of emergency core cooling systems (ECCS) and the validity of the computer codes used to predict ECCS performance. The experimental program has focused primarily on the class of accidents known as large loss-of-coolant accidents (LOCA's). In the 3 years, additional information has been obtained from LOFT regarding small LOCA's and transients. The reason that the NRC's ACRS recommended termination of the NRC program in LOFT is that questions of greatest concern to the NRC have been answered, and the value of further testing to NRC was considered to be less than the cost of operating the program.

As a result of DOE's reassessment of LOFT's capabilities and the R&D needs in the U.S. and abroad, DOE concluded that it would be wise to continue the operation of LOFT, but with a different focus for the experimental program. This new program would address, in addition to regulatory issues,experiments of interest to reactor designers and operators. In the opinion of technical experts, both in the U.S. and in other countries, it was also very important that LOFT remain available to address any new reactor safety concerns which might arise in the future.

Question: Please describe the research and development work which will be conducted at LOFT and how this differs from the type of research that was conducted while the facility was operated by the NRC.

Answer: The DOE has succeeded in forming, under the auspices of the Organization for Economic Cooperation and Development (OECD), an international consortium consisting of nine countries plus the Electric Power Research Institute (EPRI). These members have combined to select the planned program which includes the following experiments:

- a complete and unrestored loss of feedwater; a demonstration of the use of primary system feed and bleed to bring the plant to a safe shutdown condition
- two small breaks in the hot leg of the primary circuit; one with coolant pumps left running, the other with the pumps shut down
- two large breaks; one in the cold leg of the primary circuit, one in the hot leg
- two accident scenarios leading to fuel damage designed to measure fission product release and transport to the break; one at moderately high fuel temperatures, the other at higher temperatures.

The thermohydraulic experiments (first 3 bullets) fill in and supplement areas not yet covered by NRC's program. The fuel damage experiments are new to the program and are of great interest to a number of the Project member countries, to DOE and to EPRI.

Question: Please explain why NRC should not contribute to the operation of the facility for the tests it wants to have conducted at LOFT. The Subcommittee understands that the $25 million to be provided by NRC is for D&D of LOFT for the completing of old experiments.

Answer: The $25 million from the Nuclear Regulatory Commission is to complete the final LOFT test planned by NRC, now integrated into the Consortium test program. It is not to be used for decontamination and decommissioning (D&D) of LOFT. D&D is the responsibility of DOE.

Question: Please identify the foreign participants in the LOFT Program and their expected contributions.

Answer: Foreign contributions are as follows:

CONTRIBUTIONS

Contributions	Amounts in U.S. Dollars
Austria	360,000
FRG	5,000,000
Finland	290,000
Italy	2,600,000
Japan	5,000,000
Sweden	710,000
Switzerland	750,000
United Kingdom	5,000,000
Total Contributions from Foreign Sources	19,710,000

These contributions represent 38 percent of the total costs for the additional three-year program beyond that originally planned of NRC.

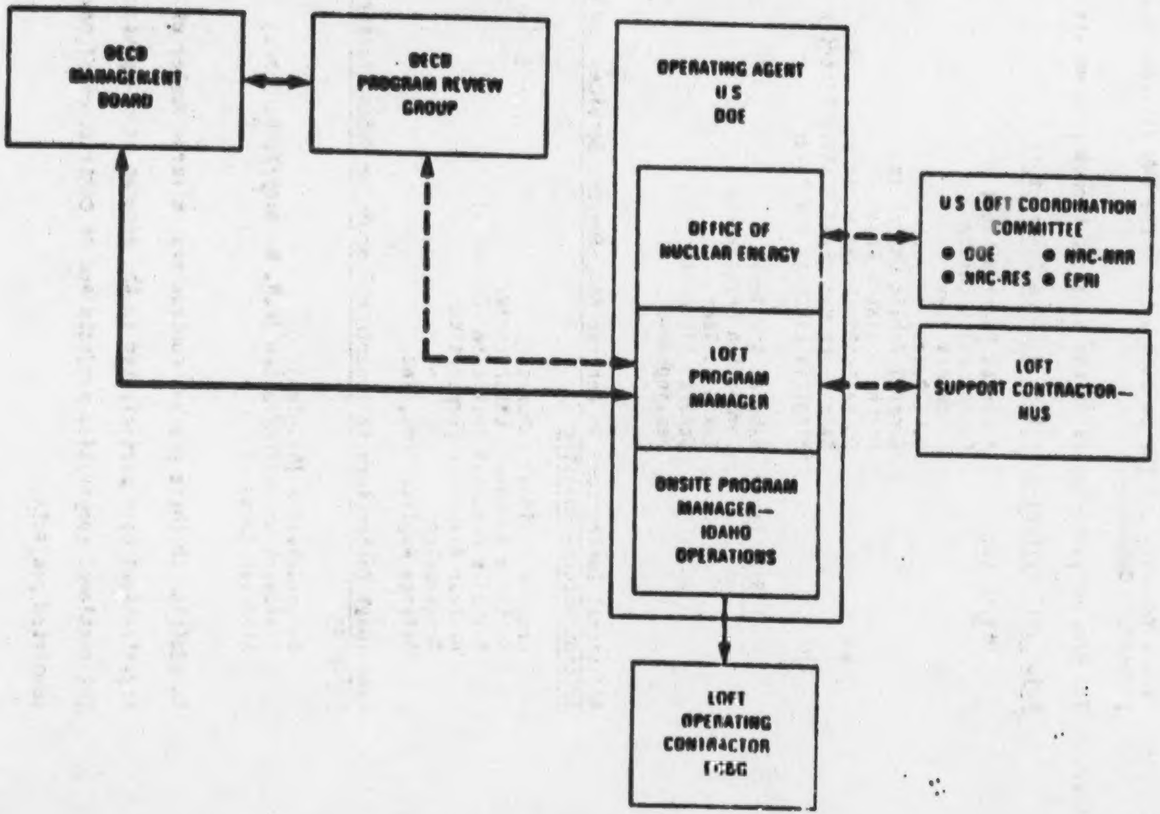
Question: Please identify the minimum funding level for LOFT to keep it operating in FY 1984.

Answer: The intended funding is $25.5 million. Of this, $15 million is to be paid by the U.S. Government (DOE) and the remaining $10.5 million by foreign sources and the Electric Power Research Institute. We have not prepared estimates relating to a lower or zero rate of testing, but suggest that this would be a less efficient approach and would probably lead to a reduction in foreign funding rates.

Question: Please explain how the "consortium of participants" will direct the LOFT program.

Answer: The number and type of OECD LOFT program experiments have been agreed to by the participants in the formal agreement. Subsequently, management of the project is accomplished by the management organization shown in the attached figure. Consortium participants will direct the program through the Management Board which decides questions involving policy, costs, program, reporting and report distribution, and through the Program Review Group which provides technical advice informally to the Project and formally through the Management Board. Both the Management Board and the Review Group interact with the contractor through the LOFT Program Manager, who is an employee of DOE. DOE agreement is required for decisions concerning insurance and decisions which may involve facility and personnel safety on which might prejudice the utilization of the LOFT facility. NRC has sole responsibility for specifying the conditions of one test for which they contributed $25M in FY 1983 funding.

OECD LOFT PROJECT MANAGEMENT


OECD MANAGEMENT BOARD
OECD PROGRAM REVIEW GROUP
OPERATING AGENT U S DOE
OFFICE OF NUCLEAR ENERGY
LOFT PROGRAM MANAGER
ONSITE PROGRAM MANAGER—IDAHO OPERATIONS
U S LOFT COORDINATION COMMITTEE
● DOE ● NRC-NRR
● NRC-RES ● EPRI
LOFT SUPPORT CONTRACTOR—NUS
LOFT OPERATING CONTRACTOR EG&G

Question: Please identify all the participants in the LWR Extended Burn-up program.

Answer: The present participants in the extended burnup program-are:

Major Utility/Fuel Suppliers Project Contractors

Utilities:
- Arkansas Power & Light
- Commonwealth Edison
- Consumers Power
- Duke Power
- General Public Utilities
- Northern States Power
- Omaha Public Power District
- Sacramento Municipal Utility District
- Virginia Electric and Power

Fuel Suppliers:
- Babcock & Wilcox
- Combustion Engineering
- Exxon Nuclear
- General Electric
- Westinghouse

Additional Contractors in General R&D, Support Services, or Major Subcontractors--Domestic

- Argonne National Laboratory
- Battelle Northwest Laboratories
- Battelle Memorial Institute (Columbus)
- Nuclear Assurance Corporation
- Transnuclear
- Science Applications, Inc.

Additional Contractors in Generic R&D or Major Subcontractors--European

- Belgonucleaire (Belgium)
- Kraftwerk Union/KFA/Petten (F.R. Germany/Netherlands)
- Studsvik (Sweden)

In addition to these present contractors, a large number of other organizations have participated in the program as co-sponsors of international cooperative projects and as contractors of now completed projects.

Question: Please identify the level of funding which will be available in FY 1984 from prior year appropriations for the LWR Extended Burn-up program, and the level of funding needed to continue the present program as originally chartered.

Answer: If no contract cancellation actions are initiated during FY 1983, an estimated $2.1 million of funding will be available in FY 1984 from prior year appropriations.

To complete all existing contracts, a total of $20 million would be needed in FY 1984 and beyond, in addition to the previously indicated amount available from prior year appropriations.

Question: Please provide figures on the funding needed in FY 1984 and beyond to carry out the LWR Extended Burn-up program to "achieve target burnups" with all the previous participants.

Answer: To achieve the full target burnups of 50,000 MWD/MTU for pressurized water reactors and 45,000 MWD/MTU for boiling water reactors, an estimated $25 million in addition to the amounts identified in the previous question will be needed. That is, a total of $45 million over and above prior years appropriations would be needed.

Question: Please explain why the LWR Extended Burn-up program should not be fully funded to achieve the "target burnups."

Answer: Light water reactor fuel performance is an area where substantial efforts have been conducted for some time by the private sector. Accordingly, we believe it is inappropriate and unnecessary for the Government to continue to augment this industrial effort.

Question: Please identify how much funding will be available in FY 1984 from prior appropriations for the LWR Radiation Dose Reduction program.

Answer: The funding in FY 1984 from prior year appropriations for the LWR Radiation Dose Reduction program is $360K. The last budget authority increase was FY 1982.

Three Mile Island (TMI) Activities

Question 1: Please describe the current status of the cleanup effort at Three Mile Island and how the R&D program relates to the cleanup activities.

Answer: The cleanup is proceeding at a reasonable pace. EPICOR-II and SDS liners are being shipped from TMI. Efforts are underway to remove the reactor head in the summer of 1983. The goal for initiation of reactor defueling is early 1985. The R&D program is limited to those activities that are of general benefit or that relate to the unique responsibilities of DOE under the Atomic Energy Act of 1954 to ensure safe disposal of nuclear waste.

Question 2: Please describe how the TMI wastes will be handled by DOE, what processing is involved, and the means of storage or disposal.

Answer: The TMI wastes are being handled in accordance with a Memorandum of Understanding (MOU) between DOE and the NRC. Under this MOU, DOE has agreed to accept wastes where generically beneficial R&D would result. In addition, DOE may accept responsibility, on a reimbursable basis, for removal, storage, and disposal of other wastes that cannot be disposed of in commercial low-level waste burial facilities.

Question 3:	Please explain what and where the "computer data bank" is, and provide the cost figure for this computer system.
Answer:	The "computer data bank" is maintained at the Electric Power Research Institute (EPRI) ZYTRON computer at Palo Alto, California. EPRI pays for the operation of the computer. DOE's costs associated with providing data to the computer is $200,000. The computerized data base is a compilation of all data (sample analyses, memos, findings associated with R&D and cleanup, etc.) that is related to TMI-2. The file contains data from the time of the accident to the present. The file contains GPU, NRC, DOE, EPRI, and contractor generated data. Individuals seeking information regarding TMI-2 can access the computer system through EG&G Idaho, Inc. upon request.

Combustion Engineering, Inc.
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Tel. 202/296-1240

BRUCE J. MacPHERSON
Manager
International Government Affairs

March 9, 1983

The Honorable
Marilyn L. Bouquard
Chairman
Subcommittee on Energy Research
Committee on Science and Technology
B374 Rayburn Building
Washington, DC 20015

Dear Madame Chairman:

We request that the enclosed written testimony be submitted for the record regarding the Subcommittee's hearings on March 9 on converter reactor systems.

Combustion Engineering has been a long-time supporter and participant in the development of a high temperature gas-cooled reactor program sponsored by the Department of Energy. We greatly appreciate your continuing support of the program.

If you or your staff have any questions about the testimony or Combustion Engineering's activities in the HTGR program, we are at your service.

Sincerely yours,

Bruce J. MacPherson

BJM:khm
Enclosure

STATEMENT SUBMITTED FOR THE RECORD

SUBCOMMITTEE ON ENERGY RESEARCH AND PRODUCTION

COMMITTEE ON SCIENCE AND TECHNOLOGY

UNITED STATES HOUSE OF REPRESENTATIVES

FY 1984 DOE AUTHORIZATION

HIGH-TEMPERATURE GAS-COOLED REACTOR PROGRAM

Dr. Charles L. Storrs
Director of Advanced Development
Nuclear Power Systems
Combustion Engineering, Inc.
March 9, 1983

Combustion Engineering, Inc., welcomes this opportunity to support the continued development of the High Temperature Gas-Cooled Reactor (HTGR).

The current surplus of world-wide oil production and the apparent adequacy of domestic electric generating capacity during a prolonged period of world-wide recession must not be allowed to obscure the basic need to ensure adequate energy for the future at an affordable price. The time required to make significant changes in energy sources is measured in decades. Over this time scale, few would disagree that oil resources will become more difficult and more expensive to discover and develop. Similarly, a growing and prosperous national economy will require increasing amounts of electrical energy. To respond successfully to these long-term challenges, it is essential that a steady and well-planned program be followed to develop and demonstrate alternative resources. Even after the feasibility and economic potential of an alternative has been demonstrated, decades will pass before the industrial potential can be in place to produce and operate a new energy source and many years to generate the enormous capital investment to deploy it on a scale sufficient to have an impact on resource utilization. It will require statesmanship of a high order to carry forward the necessary first steps now when the need may not be felt for many years.

Among the pressing needs of that future era will be liquid fuels for the transportation section--currently 25% of U.S. primary energy requirements. No adequate substitute for liquid fuels has been found for this application. The technology to produce liquid fuels from coal has been known for many years. The high cost of the process compared to petroleum has prevented its general application. However, with the expected increase in oil prices over the years, coal liquefaction will become increasingly attractive from an economic point of view. The thorough energy study by the International Institute for Applied Systems Analysis[1] suggests production in the free world of 35 million barrels per day by coal liquefaction by the year 2030.

The same reference provides a corresponding coal production figure of 12 billion tons per year. Such an enormous production rate would place a great burden on facilities for mining and transportation and for the disposal of wastes. Furthermore, the environmental impacts of burning so much coal may impose a serious restraint. Here, then, is where the High Temperature Gas-Cooled Reactor can make a possibly decisive contribution.

The High Temperature Gas-Cooled Reactor has the unique capability among nuclear systems to generate heat at the very high temperatures needed for coal liquefaction and thermo-chemical applications. The long-term trends discussed above make nuclear heat a most valuable ingredient in coal liquefaction. The potential for future reductions in cost and in environmental impact amply justify the comparatively modest sums needed at this time to continue the HTGR development and demonstration program.

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(1) Wolf Haefele, Energy in a Finite World, Ballinger Publishing Company, Cambridge, Massachusetts, vol. 1, p. 147.

However, if this were the only reason for developing the HTGR, it is doubtful that it would be pursued, considering the many other pressing needs facing this Committee. Fortunately, the HTGR has other unique attributes. Essential to the continued application of nuclear power in this country is public confidence in the safety of nuclear plants, and the confidence of investors, operators, and public utility commissions in the financial wisdom of a nuclear commitment. Inherent characteristics of the HTGR, particularly the high heat capacity of the core and its ability to withstand extremely high temperatures, provide a large margin to core damage even in the event of a serious accident. It is thus relatively insensitive to many of the hypothetical accident assumptions that have burdened nuclear licensing of other types of reactors. The HTGR should therefore be a more acceptable nuclear option to those people who continue to be concerned about nuclear safety.

Another attractive characteristic of the HTGR is the low radiation in the reactor building. This permits improved accessibility for operation and maintenance and reduces the radiation exposure to plant workers. These are important advantages from the operator's point of view.

Economic calculations show that an HTGR, using today's technology, can generate power at about the same cost as a light water reactor, once the initial first-of-a-kind engineering costs have been accounted for and the financial and technical risks of the first plant have been overcome. Cost estimates show that further development of the HTGR, once the Lead Plant has been built and has accumulated operating experience, should be self-supporting and can be handled by the private sector.

A Lead Project Strategy Plan has been prepared by Gas-Cooled Reactor Associates with the advice of the other program participants. This Plan sets forth in general terms the appropriate roles of the Government, the manufacturers, and the users in designing, building and operating the Lead Plant. It provides for flexibility and an opportunity for all participants to evaluate their risks and costs before proceeding to the next step. We believe that this Plan represents a reasonable basis for involving the private sector in this important program.

In accordance with the general provisions of the Plan, Combustion Engineering, Inc., looks forward to designing and manufacturing the steam generators and other heat exchange components of the Lead Plant. A transfer of HTGR steam generator technology from GA Technologies to C-E has proceeded smoothly and rapidly during the past year under DOE contract, and we expect to complete this transfer by the end of this year.

The Strategy Plan envisions cooperative effort involving a number of vendor/suppliers functioning as a team to design and manufacture the Lead Plant. Specific arrangements for this team are to be established during the current conceptual design phase. We have been discussing with GCRA and GA Technologies the appropriate ways to bring our experience and abilities to bear on this task, and look forward to reporting to you on this point next year.

Thank you for this opportunity to express our continuing support for the HTGR program.

EXXON NUCLEAR COMPANY, Inc.

600 - 108th Avenue N.E., C-00777, Bellevue, Washington 98009, Telephone (206) 453-4300

P. R. McMURRAY
President and Chief Executive Officer

March 8, 1983

The Honorable Marilyn L. Bouquard
Chairperson, Subcommittee on Energy
Research & Production
Committee on Science and Technology
U.S. House of Representatives
2334 Rayburn House Office Bldg.
Washington, D.C. 20515

Dear Chairperson Bouquard:

Exxon Nuclear Company is pleased to have the opportunity to submit written comments relative to your subcommittee's consideration of the Department of Energy's proposed budget for FY 1984. Our comments are limited to a discussion of the level of proposed funding for the Light Water Reactor Extended Burnup Program.

As you know, the Department of Energy (DOE) has been conducting a Light Water Reactor Extended Burnup Program for several years. The principal objective of this effort is to develop nuclear fuel that is capable of achieving higher burnups than have been accomplished with current technology. There are presently five U.S. fuel vendors, including Exxon Nuclear Company, Inc. (ENC), that are participating with several utilities in the Extended Burnup Program. ENC participates as a subcontractor to the Consumers Power Company on two of the 14 DOE contracts. Work on one contract is directed towards demonstrating the extended burnup capability of standard ENC fuel in the Big Rock Point boiling water reactor. Work on the other contract is directed towards developing and demonstrating advanced fuel concepts whose improved resistance to pellet-clad-interaction failure would eliminate fuel-related power maneuvering restrictions and allow the fuel to be irradiated to higher burnup levels. This program is also being conducted at the Big Rock Point reactor and at a test reactor in Sweden.

It is widely recognized that there are very large potential economic benefits which could be achieved if the Extended Burnup Program is completed and nuclear fuel capable of higher burnups is commercially implemented. The General Accounting Office in a September 1981 report cited potential savings to the utility rate payer of nearly $12.7 billion (in constant 1981 dollars) through the year 2000 if the program is completed at a cost of $33 million (constant 1981 dollars). Thus, the benefit to cost ratio is very high. In addition, because nuclear fuel would remain in the reactors for longer periods of time in achieving the higher burnups, the spent fuel generation rate could be reduced by as much as 40 percent. This would, in turn, reduce the quantity of spent fuel which must be stored and/or reprocessed prior to disposal of the radioactive waste portion.

The DOE FY 1984 Congressional Budget report has recommended that funding for the Extended Burnup Program be reduced significantly. If this is done, most of the benefits cited by the GAO will not be achieved and the utility rate payer will not obtain the benefits from this program and higher electrical bills will be the result. Many of the programs under the LWR Extended Burnup Program have had a high front-end investment whose value will only be realized if the programs are continued through to a logical completion. In the case of our advanced fuel program, the Fuel Performance Improvement Program (FPIP), it was not until September 1982 that the first power ramping experiments were able to be carried out on fuel irradiated in the Big Rock Point reactor. These experiments occurred approximately five years after initiation of the FPIP. The experiments are essential to test and demonstrate the capabilities of the advanced fuels to meet the program objectives. The next significant series of power ramping tests is scheduled to occur in January 1984. If this second ramping series, which is aimed at testing advanced fuel performance at higher burnup, were to be cancelled, the value of the front-end investment would be significantly diminished.

In view of the above ENC strongly supports the continuation of the current five-fuel vendor LWR Extended Burnup Program so that the full potential economic and waste management benefits can be realized. If the proposed DOE program funding reductions are implemented and the program reduced to one U.S. fuel vendor, the potential benefits will be significantly reduced and may be focused on one reactor type (either boiling water reactor or pressurized water reactor but not both). Also, one fuel vendor may be given an unfair competitive advantage over the other four.

Therefore, to ensure that all the potential benefits of the Extended Burnup Program are realized, Congress should provide adequate funding for the completion of all extended burnup projects currently underway.

Very truly yours,

Paul R. McMurray /CDS

P.R. McMurray

STATEMENT

to the

SUBCOMMITTEE ON ENERGY RESEARCH AND PRODUCTION

of the

HOUSE COMMITTEE ON SCIENCE AND TECHNOLOGY

E. P. Wilkinson
President

INSTITUTE OF NUCLEAR POWER OPERATIONS

March 9, 1983

OVERVIEW

The Department of Energy (DOE) is charged with the responsibility for research and development (R&D) in domestic energy matters. One major R&D effort is in the area of commercial nuclear energy, but the United States does not have a continuing large scale R&D program aimed at improving the safety and reliability of light water reactors. While the NRC has a substantial research program, this research focuses largely on the need for regulatory guidance rather than on results that are directly usable by utilities. The large investment represented by nuclear plants in operation and under construction is a major national asset. In my opinion, DOE should sponsor certain programs to support the commercial nuclear power industry.

In many areas, where a direct interest and commercial benefit are evident, R&D is supported by industry groups or suppliers. Some areas, such as manpower and training, however, have no direct commercial justification for R&D support, but they surely impact safety and reliability. In general, the industry does not sponsor research in these areas. Individual utilities cannot be expected to undertake such research. This work is best done by a single source for the entire industry, and DOE has been funding this kind of research through our national laboratory system to support INPO.

The White House issued a response to the President's Commission on the Accident at Three Mile Island (Kemeny Commission) on December 7, 1979. As part of this response, the President directed federal agencies with "significant experience in the training of technical personnel analogous to nuclear utility operations, such as DOD, NASA, FAA, and DOE, to cooperate with NRC and INPO in identifying areas where assistance might be provided. "Shortly thereafter, DOE took the initiative to establish communications and information exchange with INPO. This contact led to the signing, in September 1980, of a Participation Agreement between INPO and DOE. Since that time, DOE has provided contracted support to INPO in three principal areas: manpower and education, operating procedures, and plant reliability data exchange.

DOE has been instrumental in sponsoring annual surveys of nuclear-related employment and training in the electric utility industry. The results of the first two surveys helped identify and quantify the current and projected manpower problems of the industry. The information derived from these surveys is being used by individual utilities and by INPO and other organizations, including NRC and DOE, to properly focus efforts designed to alleviate shortages of qualified personnel. Future surveys will be used to monitor progress and to keep these efforts current. The manpower situation in the industry is critical for certain key positions. Government support in this area is vital to the health of the industry.

Prior to the Three Mile Island (TMI) accident and its subsequent analysis, the majority of utilities with nuclear plants provided formal training only for the personnel who were required to take NRC license exams, the reactor operators and senior reactor operators. As a result of the TMI accident analysis, the need for structured training for other key plant positions, such as non-licensed operators, mechanical and electrical maintenance technicians, and instrument and control technicians was recognized. Major efforts are required to design and develop training programs for these positions. Although substantial progress has been made since TMI, a great deal of work is yet to be done. We expect it will take several years to get the training programs developed and fully implemented. INPO, with funding assistance from DOE, has a major effort in progress to help all nuclear utilities in designing, developing, and implementing their training programs.

SUPPORT OF SPECIFIC INDUSTRY EFFORTS OF INTEREST TO INPO

Job and Task Analysis

DOE funding support also has been important to industry efforts to analyze the jobs of nuclear power plant personnel and to identify their required knowledges and skills. The results of these analyses are being used by INPO to develop model training programs for utilities to use in improving their training programs. To date the analysis of licensed operator positions at pressurized water reactor plants is complete, and the results are stored in an INPO data base. This data can be retrieved by utilities for their use in designing the content of their specific training programs.

The establishment of this data base is a major accomplishment. Current and future DOE funding support is being used to refine the existing data and expand the data base to include other nuclear power plant operating and technical positions. The relatively small amount of money being spent on this project has the potential to significantly improve the training of nuclear power plant personnel and, therefore, the safety and reliability of this nation's nuclear power plants.

Plant Procedures

Another important lesson learned from the TMI accident was the inadequacy of the then-current plant emergency operating procedures. A portion of the support provided INPO by DOE has been aimed at improving these emergency procedures. This support has contributed to the implementation of symptom-based, rather than event-based, procedures. Reports have been developed for industry that provide industrywide direction on standardized preparation, verification, and validation of emergency operating procedures.

Plant Reliability Data System

I believe that there is much to be learned from a centralized reporting system for hardware and system failures that occur in nuclear power plants. In 1982, industry assigned INPO the management responsibility for the existing failure reporting system called the Nuclear Plant Reliability Data System (NPRDS). Again, a portion of the contractual support provided INPO by DOE has been directed at training power plant personnel in the reporting and utilization of the NPRDS. This work has been effective in illustrating how to integrate NPRDS data with other sources of operating experience data to enhance power plant safety and reliability. NPRDS is a national data base and is available for use by DOE and other government agencies.

CONCLUSION

I recognize that the Administration has encouraged the transfer of R&D activities from government to industry. That is a valid goal. However, some research that is extremely important to the nuclear power industry does not have commercial justification. If government--and in the cases described in this statement, DOE--does not provide R&D support, the programs may not be undertaken in another arena. R&D, in the areas discussed, is being put to practical use in enhancing the safety and reliability of our nuclear plants. I believe it is important that the Congress continue to support this type of R&D.

Westinghouse Electric Corporation

Water Reactor Divisions

W M Jacobi
General Manager
Nuclear Fuel Division

Box 3912
Pittsburgh Pennsylvania 15230

April 25, 1983

The Honorable Marilyn Lloyd Bouquard
Chairman, Subcommittee on Energy
Research and Production
U. S. House of Representatives
Committee on Science and Technology
Suite 2321 Rayburn House Office Building
Washington, D.C. 20515

Dear Mrs. Bouquard:

Your letter of March 24, 1983, transmitted additional questions relative to DOE's LWR Extended Fuel Burnup Program. I am attaching responses to these questions. If you have any further questions or comments, please do not hesitate to contact me.

Thank you for providing us an opportunity to express our views on this important matter.

Sincerely,

W. M. Jacobi

/d

Attachment

RESPONSES TO ADDITIONAL QUESTIONS FOR DR. JACOBI
HEARING ON CONVERTER REACTOR SYSTEMS AND WEST VALLEY
MARCH 9, 1983

Q1: The Extended Burnup program has been supported by the traditional anti-nuclear and anti-breeder reactor community. This is because of the potential benefits of the program in extending uranium reserves. Would you comment on this?

A1: The LWR Extended Burnup Program and the breeder development program are, in fact, complementary and compatible activities. This is because realization of the extended burnup program goal burnups will only extend uranium resources about 10-15 percent, thus extending the breeder need date by only 3-5 years. The principal beneficiaries of this program will be the federal nuclear waste disposal activity and the utility rate payers. The breeder program, on the other hand, extends uranium resources by thousands of percent, and addresses much longer term energy generation supply needs and economics benefitting both national energy generation capabilities and the electricity consumer.

As I indicated in my testimony, the new factor underscoring the importance of the extended burnup program is its relation to the waste disposal program under the NWPA. By supporting the extended burnup program, DOE and the nation will benefit considerably from the lower volume of spend fuel generated, thereby reducing the costs of the program. The estimates I gave in my testimony show that the advantage is in the billions of dollar range for a modest investment of $11M per year in the extended burnup program.

Q2: You mentioned that a larger demonstration of high burnup fuel must be made to assure a high level of performance and integrity of the fuel. Since NRC must license any demonstration, why is DOE involvement in the demonstration so important?

A2: As mentioned in my testimony, DOE participation in the LWR Extended Burnup Program assures the early availability of extensive fuel performance data which is primarily obtained through very detailed destructive hot cell examination of the test fuel. As I further indicated, the cost of such examination is large enough that hot cell exams have been infrequently undertaken in solely privately funded fuel development programs. The data base developed through these hot-cell examinations is normally submitted to the NRC as part of the licensing process. The NRC performs its normal regulatory function in reviewing the utility reactor licensing submittals which cover the extended burnup test fuel, but the NRC has no role in the actual fuel development program data gathering and evaluation. Further, it is not appropriate for the regulatory body to be involved in development of products which they must subsequently consider in their regulatory activity.

Q3: If higher burnup fuel is made available by any one vendor, will the local public utility commissions be silent about the few utilities who are reluctant to purchase this fuel?

A3: I believe that most utilities would proceed to take advantage of this development, once it has been established by extensive testing and verification. Generation planning and fuel procurement policies and practices are, however highly dependent upon individual utility system considerations. This type of information is considered by public utility commission as part of their normal rate review practice in considering each utility application for rate adjustment. In view of the considerable variability and complexity of individual utility fuel purchasing requirements, I would not anticipate that deferral of the implementation of extended burnup fuel management by a particular utility would normally cause concern by the cognizant commission.

Q4: You state on page 5 of your testimony that without DOE program support the full benefits of extended burnup will be realized over a lengthened period. How much would the period of realization of full benefits be lengthened? Would it be helpful if DOE's hot cell facilities could be made available on a reimbursable basis?

A4: The extent to which realization of the full benefits of extended burnup will be deferred without full DOE program support will vary with each fuel vendor and individual fuel product lines. In the case of Westinghouse, the use of higher burnup in our more established product lines might only be delayed a year or two without the DOE program. However, extensions of burnup with our new optimized fuel product type could easily be delayed by as much as five years from the time at which higher burnups would otherwise be deployed commercially. It is the cost, rather than the availability of hot cell examination services, which result in the delay in extended burnup development if only private sector funding support exists. Excellent hot cell facilities are available to the fuel vendors through existing not-for-profit research institutions. It is not clear whether existing DOE hot cell facilities are appropriately sized and equipped for these examinations, or whether significant economics could be achieved.

Babcock & Wilcox
a McDermott company

Nuclear Power Generation Division
3315 Old Forest Road
P.O. Box 1260
Lynchburg, Virginia 24505-1260
(804) 385-2000

Congresswoman Marilyn Lloyd Bouquard
Chairman
Subcommittee on Energy Research & Production
U.S. House of Representatives
Suite 2321 Rayburne House Office Building
Washington, D.C. 20515

April 25, 1983

Congresswoman Bouquard:

Thank you for the questions concerning my testimony before the subcommittee hearing on DOE's LWR Extended Fuel Burnup Program for FY 1984. I have attached responses to the questions of your letter of March 25, 1983.

I appreciate the opportunity to testify in support of the LWR Extended Burnup Programs.

Sincerely,

Charles W Pryor Jr.

Charles W. Pryor, Jr.
Manager, Nuclear Fuel Services
Babcock & Wilcox

Additional Questions for Dr. Pryor

Hearing on Converter Reactor Systems and West Valley March 9, 1983

Question 1

The Extended Fuel Burnup Program has been supported by the traditional anti-nuclear and anti-breeder reactor community. This is because of the potential benefit of the program in extending uranium reserves. Would you comment on this?

Response

The LWR Extended Burnup Program helps to assure an economical and plentiful supply of uranium and a minimum of spent fuel waste. The Extended Burnup Program technology leads to about a 15% increase in the efficiency of uranium utilization and a 40% reduction in spent fuel waste, thus, conserving valuable national resources and maintaining the viability of the existing LWR systems in the interim period while breeder technology is being commercialized. Breeder reactors increase the recoverable energy from uranium ore by a factor of more than 60 over LWRs. Babcock & Wilcox supports the development of breeder reactor technology and believes that the industry and government should proceed with the Clinch River Breeder Reactor demonstration program.

Question 2

You mentioned that a larger demonstration of high burnup fuel must be made to assure a high level of performance and integrity of the fuel. Since NRC must license any demonstration, why is DOE involvement in the demonstration so important?

Response

Licensing of any demonstrations by the NRC will be required; however, the need for a large scale demonstration is primarily commercial - not regulatory. Today, fuel integrity levels are so high that the probability of encountering a defect in a limited scale irradiation is small. Large scale demonstrations are required to obtain a statistically significant data base. The few assembly demonstrations, i.e. limited scale irradiations that are being conducted now, provide the initial verification required before proceeding to larger scale demonstrations involving batches of fuel, typically 50-70 fuel assemblies. Acceptable performance from these larger numbers of fuel assemblies is necessary to establish the confidence levels on performance that will allow commercial offerings to be made.

The DOE role is one of technological leadership in sponsoring programs that demonstrate, through limited scale irradiations, that burnup extensions are feasible. The large scale irradiations will proceed under commercial arrangements between the fuel vendor and the utility and under NRC established licensing procedures. Thus, the DOE involvement provides the initial thrust needed to gain industry acceptance.

Question 3

If higher burnup fuel is made available by any one vendor, will the local public utility commissions be silent about the few utilities who are reluctant to purchase this fuel?

Response

The purchase of fuel by a utility is usually a complex decision involving many factors. Among the most important factors in the selection of a nuclear fuel vendor are price, reliability, performance, flexibility, and service. The price paid for the fuel itself is only one component of the overall costs of supplying electricity to the consumer, and for nuclear generation, it is usually a relatively small component. Factors such as the amount of time the reactor is on-line producing electricity and the utility's flexibility in tailoring fuel cycle lengths to their electrical demand schedule can be as important as fuel costs alone. Poor fuel performance, that is an increase in fuel defects leading to increased outage time, personnel exposure, and replacement fuel, can quickly offset the benefits gained from new fuel designs or improvements, such as extended burnup. While it is likely public utility commissions will continue to scrutinize fuel costs and expect utilities to provide their customers with the lowest cost practical sources of electrical generation, it is unlikely they could justify forcing a utility to purchase fuel from a new supplier solely on the basis of a higher burnup fuel offering. Also, fuel supply contracts are generally long-term supply arrangements, and they usually involve costs for cancellation, thus, forcing a utility to change vendors would probably not be cost effective.

Question 4

On page 5 of your testimony, you state that attempts to directly market the Extended Fuel Burnup Programs to utilities have been generally unsuccessful. How will DOE participation change this position of the utilities? Is this statement not inconsistent with your statement on page 5 of your testimony that two thirds of the LWR owners have made a decision to move to higher burnup fuels?

Response

The statement on page 5 is that attempts to directly market extended burnup development programs to utilities have generally been unsuccessful. It is difficult for the utilities to obtain the front end money necessary to finance research and development programs. DOE participation has provided the money needed to launch the development programs. The statement that two thirds of the LWR owners have made a decision to move to higher burnup indicates that the DOE efforts have been very successful in overcoming the inertia required to spur acceptance of extended burnup in the commercial sector. However, completion of the DOE LWR Extended Burnup Program is needed to maintain the momentum that has been established.

Question 5

If two thirds of the LWR owners have made a decision to move to higher burnup fuels, then isn't there an extremely great incentive for anyone of the five vendors to be the first to offer high-burnup fuel to this potentially large market?

Response

Most fuel supply contracts are multi-year, long term contracts. Nearly 70% of the fuel contracts for the next 25 years are already in place and no new domestic nuclear steam supply system sales are expected in the near future. The size of the reload market that is available for competitive bidding over the short term would make the financing of the required development program a risky commercial venture. Furthermore, the fraction of the total fuel costs that is fabrication-related yields little profit potential for the vendors due solely to extended burnup. It is unlikely that any one fuel vendor could justify the necessary R&D expenditures based on the size of the available market and the concomitant shop load reduction associated with extended burnup. Implementing extended burnup would, at best, proceed at a slow pace. The LWR Extended-Burnup Program is providing the impetus necessary to modify the existing long term contracts and begin the implementation of extended burnup now.

Question 6

On page 6 of your testimony you state that the newly enacted Nuclear Waste Policy Act of 1982 reduces the benefits of extended burnup for the utilities. Please identify what provisions you are referring to. Aren't there other benefits to the Extended Fuel Burnup Program for these utilities, such as, reducing the need for on-site storage of spent fuel and reducing their payments to DOE for spent fuel disposal? As you know, under the Waste Act, each utility contributes only its pro rata share of the cost of disposal. If the utilities have less spent fuel for disposal, they will, therefore, have less of a fee to pay for disposal services.

Response

Section 302 of the Nuclear Waste Policy Act of 1982 defines the fees to be paid by utilities for spent fuel disposal. The disposal fee to be paid for spent nuclear fuel used to generate electricity in a civilan nuclear power reactor prior to April 7, 1983, would depend on the amount of fuel to be disposed. However, for fuel used to generate electricity on or after April 7, 1983, the fee to be paid by each utility for waste disposal is based on the amount of electricity generated with nuclear capacity (i.e. a flat fee of 1 mil per kilowatt hour of net electrical energy produced from nuclear units). This means that the utility will be charged the same amount for a given fuel cycle length regardless of whether that fuel cycle involves 60 fuel assemblies and their associated volume of waste, or it involves 50 fuel assemblies, higher-burnup, and their associated lower volume of waste. Thus, the Act as currently written does not create an incentive for the utility to reduce the future volume of spent fuel generated for waste disposal. However, there are other benefits for the utilities from the Extended Burnup Program.

Department of Energy
Washington, D.C. 20585

June 8, 1983

Honorable Marilyn Lloyd
Chairman
Subcommittee on Energy Research
and Production
Committee on Science and Technology
House of Representatives
Washington, D.C. 20515

Dear Ms. Lloyd:

Attached are responses to the questions in your letter of May 24. They relate to the converter reactor systems program budget and the March 9 hearing of the Subcommittee on Energy Research and Production at which Shelby Brewer, Assistant Secretary for Nuclear Energy, was the witness.

If you have any questions or wish further information, please do not hesitate to call Diana Diamond or Tom Pretorius of my staff at 252-4277. They will be pleased to assist you.

Sincerely,

Thomas H. Pretorius
for Robert G. Rabben
Assistant General Counsel
for Legislation

Enclosure

cc: Ms. Julie Shisler
Committee Staff

Question: Please identify the minimum funding level for LOFT to keep it operating in FY 1984. If you have not prepared estimates relating to a lower or zero rate of testing, please do so.

Answer: Three cases may be considered for comparison purposes.

(a) Current program of three experiments. This is the current plan and includes analysis of previous (FY 1983) experiments and preparations for future experiments. The funding level for this case is $26 million. (Of the $26 million, $15 million represents DOE's request for FY 1984; $11 million comes from non-Federal-government sources.)

(b) No experiments, but retain entire labor force, maintain facility, and proceed with long-lead external contracts, in readiness to continue with program in FY 1985. The funding level for this case is $23 million.

(c) No experiments, but maintain and support facility and retain management infrastructure; no analyses, engineering, nor crafts work involved in planning and preparation for experiments. The funding level for this case is $11 million.

For cases (b) and (c), it should be expected that all non-DOE support would be lost. This would leave DOE to cover the full cost as compared witn the current request of $15 million for DOE's share, which covers $10 million for experimental programs and $5 million for D&D.

Question: Since LOFT was originally operated by NRC, why shouldn't NRC be responsible for at least a portion of the D&D expenses?

Answer: Before the OECD LOFT consortium was contemplated, funding for the D&D of LOFT was to be provided by the NRC. When the consortium was formed, it was agreed between DOE and NRC that NRC meet this obligation by providing to DOE the estimated D&D cost of $15 million through three equal payments of $5 million, to be made in fiscal years 1984, 1985, and 1986.

To provide for better accountability and fiscal management, this D&D cost was transferred to DOE together with NRC's planned budget of $5 million for each of the same years, to cover their contributions towards the consortium program.

Question: Please identify the minimum funding level for LOFT to keep it operating in FY 1984. If you have not prepared estimates relating to a lower or zero rate of testing, please do so.

Answer: Three cases may be considered for comparison purposes.

(a) Current program of three experiments. This is the current plan and includes analysis of previous (FY 1983) experiments and preparations for future experiments. The funding level for this case is $26 million.

(b) No experiments, but retain entire labor force, maintain facility, and proceed with long-lead external contracts, in readiness to continue with program in FY 1985. The funding level for this case is $23 million.

(c) No experiments, but maintain and support facility and retain management infrastructure; no analysts, engineering, nor crafts work involved in planning and preparation for experiments. The funding level for this case is $11 million.

For (b) and (c), it should be expected that all non-DOE support would be lost. This would leave DOE to cover the full cost as compared with the current request of $15 million, which covers $10 million for experimental programs and $5 million for D&D.

Question: Please describe the current status of the cleanup effort at Three Mile Island and how the R&D program relates to the cleanup activities.

Answer: The radioactively contaminated water which was released to the basement of the Auxiliary and Fuel Handling Buildings during the accident has been cleaned up using the EPICOR-II system. The low level waste from EPICOR-II which was suitable for commercial shallow-land burial has been shipped to a commercial burial site by the plant owner, General Public Utilities Nuclear Corporation. EPICOR-II generated fifty high activity prefilters which are not suitable for commercial shallow-land burial as is. DOE is accepting these prefilters as explained in the answer to the following question. As of May 31, 1983, 39 of these prefilters had been shipped from TMI.

The radioactively contaminated water from the basement of the Reactor Building and in the Reactor Coolant System has been cleaned up using the Submerged Demineralizer System. DOE is also accepting these wastes as explained in the answer to the following question. As of May 31, 1983, 9 of the liners containing this waste had been shipped from TMI.

Surfaces within the containment building have been decontaminated of loose surface debris. In addition, the first phase of a dose reduction campaign to lower worker exposure within containment has been completed.

Efforts are underway to remove the reactor head in the summer of 1983. Parallel efforts are being initiated to remove the reactor plenum by the end of 1984 and to initiate defueling early in 1985.

The relationship of the R&D program to the cleanup activities is consistent with Administration policy which limits the DOE R&D program to those activities that are of general benefit or that relate to its unique responsibilities under the Atomic Energy Act of 1954 to ensure safe disposal of nuclear waste. Therefore, DOE is conducting a Data Acquisition Program whose objective is to obtain important R&D data which is of generic value to the safety of light water reactors. DOE is also conducting a Waste Immobilization and Reactor Evaluation Program whose objectives are to conduct research and development on immobilization of abnormal reactor waste products and; to examine the TMI-2 reactor and core components in-situ and to support development activities associated with the reactor defueling.

While the DOE program is limited to activities of general benefit, certain of these activities offset costs which otherwise might have to be borne by the reactor owner. This "offset" was recognized by the General Accounting Office in EMD-82-28, "Impact of Federal R&D Funding on Three Mile Island Cleanup Costs" dated January 15, 1982.

Question: Please describe how the TMI wastes will be handled by DOE, what processing is involved, and the means of storage or disposal.

Answer: Certain TMI wastes are being handled by DOE in accordance with a Memorandum of Understanding between DOE and the NRC. Under this MOU, DOE has agreed to accept wastes where generically beneficial R&D would result. In addition, DOE may accept responsibility, on a reimbursable basis, for removal, storage, and disposal of other wastes that cannot be disposed of in commercial low-level waste burial facilities.

The first TMI wastes which are being addressed by DOE are those generated by the EPICOR-II system which was used to clean up the contaminated water in the basement of the Auxiliary and Fuel Handling Buildings. DOE has agreed to accept the fifty first stage EPICOR-II prefilters for characterization, packaging for safe shipment, research and development, and preparation for disposition. Two of these prefilters were shipped to Battelle Columbus Laboratory where the ion exchange media were characterized. The prefilters were then shipped to the Idaho National Engineering Laboratory (INEL) where the liners containing the ion exchange media were examined by metallographic means to confirm their integrity. The remaining prefilters are being shipped directly to the INEL. As of May 31, 1983, 39 of the prefilters had been shipped to INEL and the remaining 11 were at TMI. The DOE goal is to have all fifty shipped to INEL by the end of FY 1983.

While at INEL, the prefilters will be stored in two special storage silos in the TAN 607 Hot Shop. Four to six will be used in the research and development program which encompasses resin degradation studies and resin solidification studies. The resin degradation studies will assess any possible degradation of resins caused by internal ionizing radiation. The resin solidification studies will explore the use of polymer or cement as media for solidifying the EPICOR-II ion exchange media. Solidified samples will be subjected to compression and leach testing as well as long-term leach tests in lysimeters.

It is contemplated that the majority of the prefilters will be disposed of by the General Public Utilities Nuclear Corporation at a commercial low level waste burial ground. DOE is presently developing and evaluating a High Integrity Container which would be suitable for use in such disposal of the prefilters. DOE plans to conduct a burial demonstration of one EPICOR-II prefilter in a High Integrity Container at a commercial burial facility before the end of 1983.

The second major class of wastes with which DOE is involved is that generated by the Submerged Demineralizer System (SDS) which was used to clean up the contaminated water in the basement of the Reactor Building and in the Reactor Coolant System. DOE has agreed to accept approximately twenty high specific activity zeolite liners from the SDS for use in its research and development program.

Three of these liners have been shipped to the Pacific Northwest Laboratory where they were mixed with glass-forming chemicals in an existing furnace and made into glass logs. These three radioactive demonstrations established the technical feasibility of vitrification as a disposal option for TMI's highly loaded radioactive waste. The remaining liners are being shipped to Rockwell Hanford Operation where they will be buried in a retrievable three foot thick steel reinforced concrete containers. As of May 31, 1983, a total of six liners have been shipped for burial. The pressure and temperature in a representative buried liner will be monitored for several years. This program will establish the option of burial in a concrete container for these wastes.

The third major class of TMI wastes which DOE is addressing are those contained in the Makeup and Purification System which had letdown flow from the Reactor Coolant System circulated through it for over eighteen hours on the day of the accident. The primary DOE activities have concerned characterization of the resins and analysis of alternate methods to remove these resins. A final method of storage or disposal has not been decided at this time.

DOE is also conducting preliminary investigations of the practicality of accepting Transuranic Wastes from TMI for storage on a reimbursable basis.

Details of DOE's TMI waste program are contained in pages 51 through 73 of the attached 1982 Annual Report for the TMI program.

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